THYROID UPTAKE SYSTEM
ATOMLAB 930

OPERATION MANUAL

187-010
187-020
187-025
187-015

BIODEX
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THYROID UPTAKE SYSTEM ATOMLAB 930

This manual covers installation and operation procedures for the following products:

#187-010	Thyroid Uptake System, Atomlab 930, 115 V
#187-020	Thyroid Uptake System, Atomlab 930, 115 V, Tabletop
#187-020	Thyroid Uptake System, Atomlab 930, 230 V, Mobile
#187-020	Thyroid Uptake System, Atomlab 930, 230 V, Tabletop

NOTE: All or some of the following symbols, cautions, warnings and notes may apply to your Gait Trainer 2 and correspond to this operation manual:

Symbol	***Meaning***
⚠	*Attention, consult accompanying documents.*
⚠	*Symbol signification: Attention, se référer à la notice.*

CAUTION: Federal law restricts this device to sale by or on the order of a medical practitioner. When prescribed for therapeutic purpose, a physician should clearly define the parameters of use (i.e., total work, maximum heart rate, etc.) to reduce the risk of patient injury.

CE 0413

IMPORTANT NOTE

- Before you use this device, be certain to read the entire manual. Failure to read this manual may result in user error or inaccurate data.

WARRANTY

ATOMLAB Thyroid Uptake Systems carry the industry's best warranty.

Biodex Medical Systems backs ATOMLAB Thyroid Uptake Systems with a truly comprehensive full one-year warranty.

With this one-year warranty, quality assurance, guaranteed delivery from stock, and responsive customer service, Biodex Medical Systems gives the nuclear medicine field the right answer… ATOMLAB Thyroid Uptake Systems.

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1. INTRODUCTION

The Atomlab 930 is a complete thyroid uptake and analysis system specifically designed for nuclear medicine. Capable of performing a full range of studies this system provides fast, accurate results for Uptake Studies, Bioassays, Wipe Testing, Manual MCA Analysis, and Schilling Tests programmed for the Mallinckrodt, Squibb or Medi+Physics Dicopac® kits.

The heart of the Atomlab 930 is a microprocessor-controlled 256 channel Multi-Channel Analyzer, coupled to a 2" x 2" NaI(Tl) detector. The system offers simple, straight-forward operation using seven pre-programmed isotope keys and menu-driven prompts to guide the user step by step through each procedure. Pre-programmed keys include I-123, I-125, I-131, Co-57, Cr-51, Tc-99m and Cs-137. A user-defined <Other> key also allows for isotope identification while a 32K memory printer provides hard copy printouts for patient and department record keeping.

The Atomlab 930 has a memory of 25 patients, allowing storage of up to four uptakes on each. Additional features include an automatic self-diagnostic program, automatic calibration mode, choice of automatic or manual counting time for uptake studies, and automatic isotope decay correction of uptake measurements. These features help make this the most simple and accurate thyroid uptake system available today.

2. SETUP INSTRUCTIONS

Components and Parts

Before beginning to set up and position your new Atomlab 930 Uptake System, check to ensure that you have received each of the components and parts ordered. The following list shows all components and parts available for the Atomlab 930 system.

- Model #187-903 MCA Display Unit
- Power Cord
- Model #187-220 Uptake Stand (Optional)
- Model #187-901 printer with cables
- Model #187-796 Detector Unit (Optional)
- Model #187-246 Well Counter (Optional)
- Model #101-103 Cs-137 10 μCi Check Source (Optional)

Setup Procedure

(See Figure 1)

1. Remove the Atomlab 930 Display Unit from its packaging and place it on the large shelf of the uptake stand. The display unit keyboard should face toward the front of the stand where the user will be positioned.

2. Place the printer on the top shelf of the uptake stand.

3. If you have an optional well, secure it to the well support shelf at the bottom of the uptake stand. To do this, use a slotted screwdriver to remove the two holding brackets. Slide the well into position and replace the brackets. Now tighten down both brackets to securely lock the well in place.

4. Ensure that the display unit power switch is in the OFF position.

5. Insert the power cord plug through the cable hole and into the back of the display unit. The male end of the power cord goes to a wall socket.

6. Loosen the collimator locking knob and rotate the collimator into a vertical position with the distance rod facing down (front of collimator). Tighten the locking knob.

7. If necessary, adjust the uptake arm height. To do this, loosen the locking knob on the vertical column of the uptake stand. The uptake arm is counterbalanced so it will slide easily up or down the stand. When you are satisfied with the height, tighten the locking knob to lock the uptake arm in place.

8. Near the top of the collimator, locate the set screw. Use a 1/32" Allen wrench to loosen the screw in a counterclockwise direction until it retreats enough to allow passage of the tube assembly.

9. Remove the tube assembly and base from its packaging. You will notice that a “grounding strap” is wrapped around the base and detector. This is necessary to properly ground the detector shroud to the base and stabilize the count rate.

10. Carefully insert the detector and base assembly into the cone shaped collar and slide downward until the entire assembly is inserted. Tighten the set screw to secure the detector in place.

    NOTE: *Do not force the assembly into position, you may dent the shroud and damage the detector. If it will not slide easily into place, ensure that the set screw has been sufficiently loosened.*

11. If you have a probe, connect the detector cables to the labeled connectors on the back of the display unit. To do this, run the cables under the arm and up through the cable hole on the upper shelf. Use the cable tie, at midpoint on the bottom of the stand arm, to secure the cables. The cables need to be positioned so that when the collimator is rotated up they will not be pulled too tightly against the cable tie.

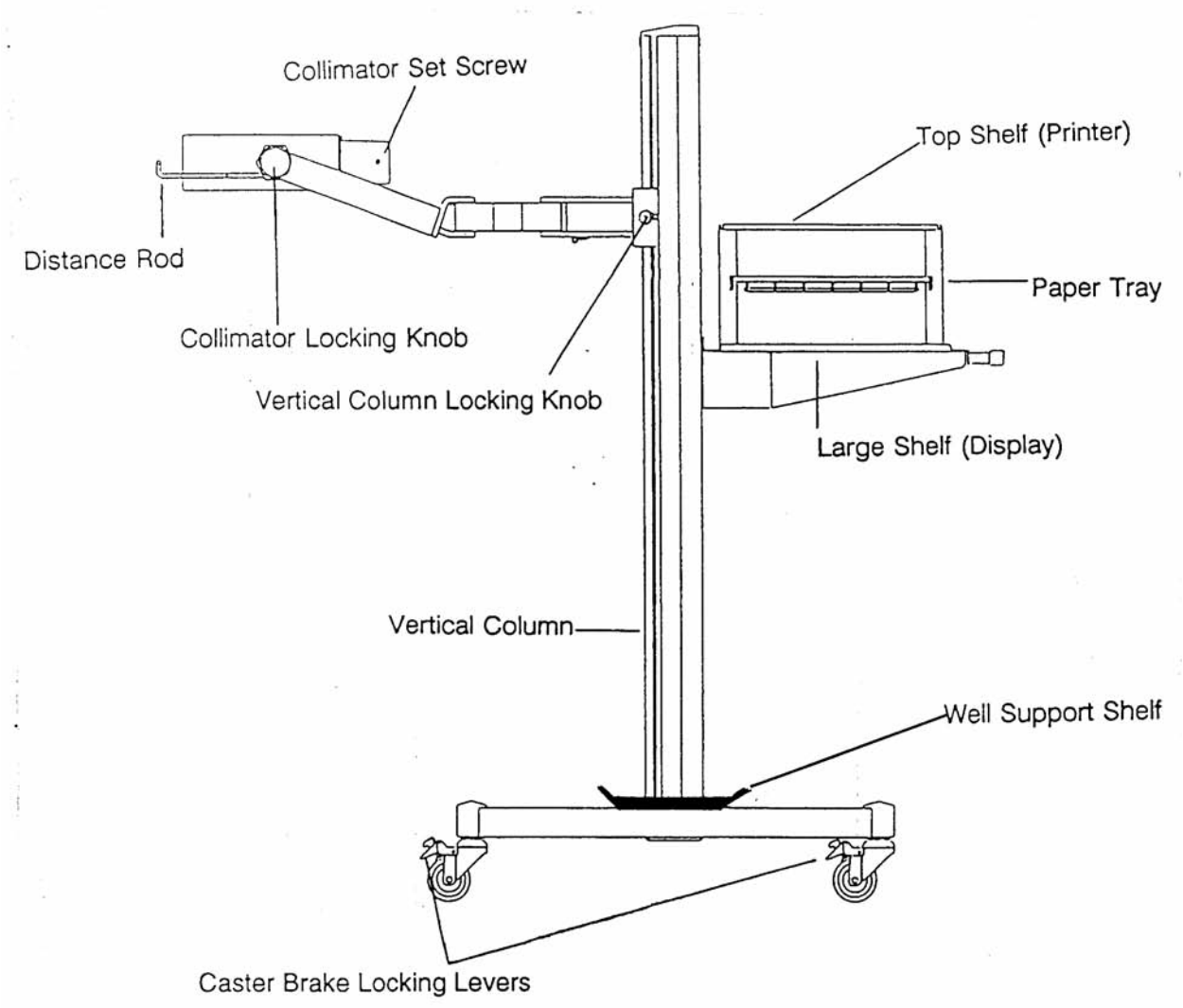


Figure 1. The MCA Uptake Stand.

The cables connect via a twist lock mechanism. Be sure to twist them on the display unit until locked in position. The cable with the short connector (BNC - thin cable) goes to the probe input signal plug. The cable with the longer connector (MHV - thicker cable) goes to the probe high voltage plug.

If using a well, you'll need to connect one end of each cable to the well and the other end to the display unit. With the well positioned on the bottom shelf, connect each cable to the well and run both cables up through the display shelf cable hole and connect them to the appropriate display unit. Use a cable tie to secure the cables. The cables connect to the display unit via a twist lock mechanism. Be sure to twist them on the display unit connectors until locked in position. The cable with the short connector (BNC - thin cable) goes to the well input signal plug. The cable with the longer connector (MHV - thicker cable) goes to the well high voltage plug.

12. Attach the printer cable's 25 pin serial connector to the top serial port on the printer's back panel. Attach the free end of the cable (9 pin connector) to the data port on the back of the display unit.

13. Connect the printer power cord to the "printer" connector on the rear of the display unit.

14. Place a stack of fan-fold paper in the paper tray beneath the printer. Feed the paper up around the back of the printer and position on the printer's tractor drive so that it is ready to print. Refer to the "Operation" instruction card provided with your printer for details on paper installation.

15. Ensure the uptake stand is positioned as desired. Press down on all four brake locking levers to lock the stand in place.

Power-Up and Self-Test

(See Figure 2)

At this point, your Atomlab 930 Thyroid Uptake System should be operational. It is recommended that the system be turned ON at least one hour before use or, if possible, left on at all times. This will provide optimum performance and will not effect the longevity of any part or component.

To power-up and run the self-test:

1. Turn the printer ON first.

2. Reach behind the Atomlab 930 and flip the POWER ON switch to the ON position. The system immediately begins an automatic self-test to ensure all aspects are functioning properly. The self-test includes:

   - Display Unit/MCA firmware and hardware checks
   - Display LED/LCD test
   - Printout of test information

At conclusion of the self-test, the system generates a printed report to display calibration information and software versions for the display unit and MCA.

The "Mode #1 Thyroid Uptake" message and the current date are now displayed on the screen. The system is ready for use.

NOTE: *Before using the system for the first time, be sure to set the High Voltage and perform the calibration procedures explained Chapter 4. For quality assurance purposes, the system should be turned ON at least two hours prior to performing these procedures for initial setup (or any time the system has been turned off for a substantial period of time).*

Your Hospital Name
Address
City, State Zip
(000) 000-0000

POWER ON AND TEST REPORT

DATE: Dec 01, 1993 TIME: 09:57

Patient Uptake ID Record:

ID	DATE	SURVEYS	ID	DATE	SURVEYS

MCA Software Version: 4.0

Display Software Version: 4.0

FWHM - Probe: 11.6% FWHM - Well: Not Performed Yet

Chi-square = 8.25 Degrees of freedom = 9 Passed

CALIBRATION:

Isotope	Peak keV	normalization factors Well	Probe	Gain	LLD keV	ULD keV
I-123	159	N/A	N/A	8	135	183
I-125	27	N/A	N/A	48	23	40
I-131	364	N/A	N/A	4	309	419
Co-57	122	N/A	N/A	12	104	156
Cr-51	320	N/A	N/A	4	272	368
Tc-99m	141	N/A	N/A	12	119	162
Cs-137	662	N/A	N/A	2	562	761
OTHER		N/A	N/A	1	117	2000

* indicates a change from the factory defaults.

ERRORS:

None.

Figure 2. A sample Power-Up and Self-Test report.

3. PROGRAMMING SYSTEM PARAMETERS

General Setup

Before using the Atomlab 930 for counting purposes, it is important that you take a few minutes and address several general system parameters which are used in all modes. These include:

- Change ROI from presets (select different isotope)
- Print Draft/Letter Quality
- Setting the system clock
- Adjusting display contrast
- Entering a facility title and address to show on all printed reports

Prompts for each of these parameters appear in sequence as the user advances through the Program System Parameters (General Setup) loop. You can set each parameter in sequence, or skip any sequence by pressing <Setup> at the appropriate prompt. To begin, press <Setup> at the "Mode #" prompt. The first option displayed is "Select Different Isotope" (change ROI from presets).

NOTE: *Press the <Clear> key to abort any option in progress, or remove any entry before it has been saved. The system will return you to the previous screen or the current entry screen.*

After completing the Program System Parameters loop and choosing a mode, you'll also need to program mode-specific parameters in the Mode Setup loop for each individual mode. This procedure is explained individually for each mode. Following is an explanation of general system parameters only.

Change Isotope ROI

The Atomlab 930 allows the user to choose between using preset isotope (or <Other> key) settings, adjusting ROI settings for the preset isotopes, or selecting a new isotope and entering the Region Of Interest.

How is ROI Determined?
The preset ROI energy window values do not change as the user switches between well or probe, regardless of the mode selected (i.e., Uptake, Schilling, MCA, etc.). The ROI is defined in units of energy (keV) and then converted to channel numbers with the keV/channel slope value that is measured during calibration. The channel number for the ROI values can and will change from probe to well if the calibration keV/channel is different between probe and well.

Example: Tc-99m has a peak energy of 140.5 keV according to the radionuclide decay scheme. The Atomlab 930 uses a default of ± 15% energy window around the peak energy. These values calculate to be 119 keV to 162 keV and are printed on the Self-Test report. When either the probe or well is selected, the ROI channels are calculated based upon the Cs-137 calibration results for that particular detector. If the calculation of the probe results in a 1.51 keV/channel on gain 8, the Tc-99m default gain, the channel ROI will be 119 keV/1.51 keV channel = channel 79 and 162/1.51 = channel 107. For the well detector, we might have a calibration of 1.33 keV/channel. In this case, the ROI channels will calculate channel 89 to 122. Even though the ROI channels are different, the energy windows are the same. This will become apparent when the spectrum for each detector is printed.

NOTE: *It is not necessary to fix a symmetrical percent around the peak. In fact, some isotopes are multi-peaked, which can cause an asymmetric spectrum.*

NOTE: *If you change the ROI, the high count rate correction will automatically reset to zero.*

Because the calibration values for the probe and well can be significantly different from each other, the high voltage must be set for each detector so that the spectrums appear in the same location. The calibration value is printed below the channel values on the spectrum report printout. After calibration (mode #6), print the spectrum. High Voltage Adjustment is discussed in the next section of this manual. Keep in mind that if a calibration is performed you must save the result in order to have it used in ROI calculations.

Change Isotope ROI Procedure

1. At the "Change ROI" prompt, press any isotope key to change the Region Of Interest of that isotope, or press <Setup> to skip and advance to the next setup prompt, High Voltage Adjustment.

2. If you select an isotope, the screen will display the isotope name and its gain setting (see chart below for gain settings).

Gain	Max keV	Half Scale
1	3000	1500
2	1500	750
4	750	375
8	375	187
12	250	125
48	64	32

   A. Lower Level Discriminator (LLD) = 0.85 times the lowest Peak keV of interest.
   B. Upper Level Discriminator (ULD) = 1.15 times the highest Peak keV of interest.
   C. Use the Setup mode to enter the Gain, LLD and ULD.

3. Use the <Up Arrow/BKGND> or <*/Down Arrow> keys to set the new gain value such that the highest Peak keV is at less than or equal to the half-scale. Press <Save> to save the new gain setting or press <Setup> to return to the default setting.

   NOTE: *It is preferable for the peak energy to be less than or equal to one-half full scale. This is especially important for eliminating spectrum broadening at very high count rates.*

   Example: For I-123 with an energy peak of 159 keV, gain is preset to 8. The maximum energy on a gain of one = 3,000 keV. For gain = 8, max energy is 375 keV, half max is 187 keV. For gain = 12, max energy is 250 keV, half max is 125 keV. The 159 keV peak is both closer to and less than 187.

4. If you have saved the new gain setting, the system now displays the isotope name and its ROI minimum keV (noted as Lower Level Discriminator on printout). Press <Save> to save or adjust the value with the <Up Arrow/BKGND> or <*/Down Arrow> keys and then press <Save> to save.

5. The screen should now display the Max keV value (Upper Level Discriminator). Press <Save> to save, or adjust the value with the <Up Arrow/BKGND> or <*/Down Arrow> keys and then press <Save> to save. The system returns to the "Change ROI" prompt.

6. If desired, change the settings for other isotopes at this point, or press <Setup> to advance to the next setup function, Print Draft/Letter Quality.

Print Draft/Letter Quality

Your Panasonic printer can provide hard copy in either draft or letter quality formats. Draft copy takes less time to print out, letter quality copy is sharper and generally used for any type of "official" report. At this point, the printer status, Draft or Letter, should be displayed. The system is factory set for draft quality.

If the print status shown is desired, press <Setup> to skip to the next parameter function, Set Clock.

To change the print status:

1. Press <Enter> to toggle between Draft and Letter quality.

2. Press <Setup> to select the displayed status and advance to the Set Clock function.

Set Clock

The Atomlab 930 clock and calendar are factory set to display the correct date and time. The display arrow pointer is always present on the display screen when the "Set Clock" prompt appears.
To change the date or time:

1. Use the number keys to enter an entire new time and date. You cannot change just one digit, you must re-key them all. As you enter each digit, the arrow pointer moves to the next until you enter the last digit. At that point, the new time and date are automatically saved and the system advances to the "Adjust Contrast" prompt.

2. If you make a mistake while entering, press <Clear>. The arrow pointer will return to the first digit of the date, allowing you to start over. Press <Clear> a second time to return to the "Mode #" prompt, or press <Setup> to advance to the "Adjust Contrast" prompt.

Adjusting the Contrast

The display contrast is adjustable from very light to very dark.

1. At the "Adjust The Contrast" prompt, press the <Up Arrow/ Bkgnd> key to darken the contrast. Press the <*/Down Arrow> key to lighten the contrast.

2. When satisfied with the contrast, press <Setup> to advance to the "Title" prompt.

Title

Enter the facility name and address at this prompt. The name you enter will print out at the top of all reports. The system uses the ASCII format. You have four lines to work with and each line will be centered on the report. Enter up to a total of 120 characters for the four lines (combined).

Titles scroll across the display from right to left as you press the <Count/Enter> key. When your Atomlab 930 system arrives, only the letter "Y" (at the far right of the screen) will be visible as the title prompt appears. There will be an <Up Arrow> beneath the "Y". The <Up Arrow> will always appear under the letter to change or select.

NOTE: *Be careful when entering characters at the "Title" prompt. Once you select a character, you cannot remove or edit it without returning to the first "Title" prompt and re-entering all the data.*

To enter a new title:

1. Press the <Bkgnd/Up Arrow> or <*/Down Arrow> key to scroll though the ASCII list of letters, numbers and symbols. The letter above the arrow pointer on the display will change with each press of the key. There is a set of lower case letters, upper case letters, numbers 1-0 and useful symbols.

2. To select any character displayed above the arrow pointer on the display, press <Count/Enter>. The selected character moves to the left and a new character appears above the pointer arrow.

3. Press <Count/Enter> to select the next character if it is correct, or scroll through the ASCII list until the appropriate character is displayed, and then press <Count/Enter>. Continue until you have entered the entire first word of your title.

4. After completing the first word of your title, scroll through the ASCII list and select the blank space. You may now enter the second word of your title.

5. After completing the first line of your title, (i.e., facility name), select the ASCII symbol for line end (↲). This will cause the title to start a second line. Proceed as above until you have entered the entire title. You may wish to enter the facility phone number as the fourth line of the title.

6. Once you have finished entering the title, select the line end (↲) symbol until the title is saved. The entry is automatically saved and the system is now ready for you to select an operating mode.

4. OPERATION

Mode Selection

Following the general Program System Parameters loop, the screen presents the currently selected mode. If you are using the system for the first time and began in mode #1, the message "Mode #1 Thyroid Uptake" should appear on your screen at this point.

You may now select a mode in which to operate (although you will have to perform a daily calibration before making any measurements). Simply press the <Up Arrow> or <Down Arrow> thumbwheel keys to scroll through your choices. The following modes are available:

Mode #1: Thyroid Uptake
Mode #2: Employee Bioassay
Mode #3: Wipe Test
Mode #4: Schilling Measurement
Mode #5: MCA Manual Use
Mode #6: Calibration

To select any mode, press the flashing <Select> key while the mode number is displayed on the small (left side) display and described on the larger (right side) display. The number lock LED will come on. Once the number lock is activated, all keys perform "lower case" functions (i.e., the <Count/Enter> key function is <Enter>, the <Bkgnd/Up Arrow> key function is <Up Arrow>). The number lock activates numbers 0-9, <Up Arrow>, <Down Arrow>, and the <Save> keys.

To cancel the current mode, press <Clear>. You can now scroll through the mode choices again, if desired.

NOTE: *A daily calibration must be performed before the Atomlab 930 will allow you to continue beyond this point. The daily calibration routine is accessible through each of the Atomlab 930's six modes, as explained below. The Chi-Square test is accessed through Mode #6 only.*

Calibration and Chi-Square (Mode #6)

(See Figures 3 and 4)

NOTE: *The system must be ON for at least one hour before performing a calibration. This will allow time for the unit to warm-up and stabilize.*

For initial setup, skip ahead and perform HV adjustment prior to calibration.

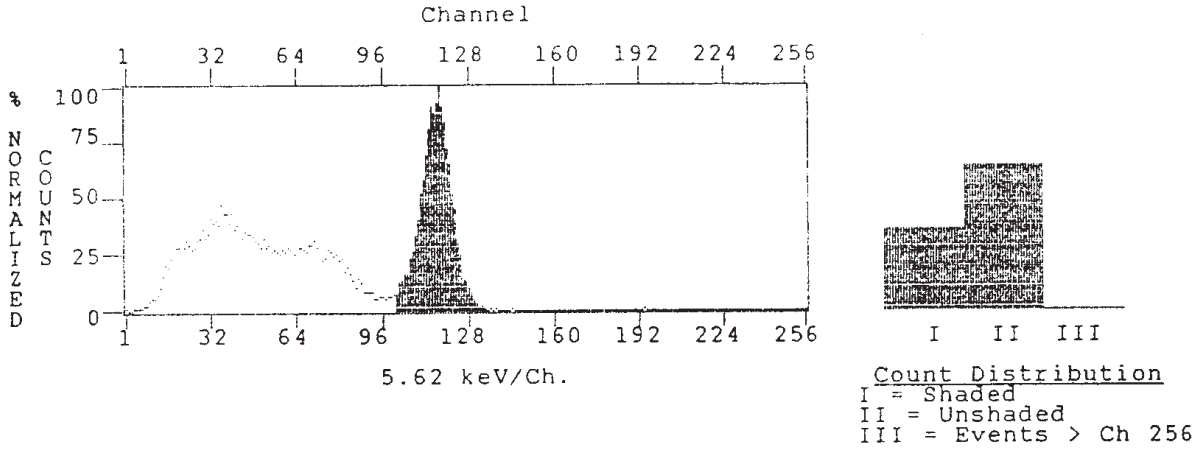
A system calibration must be performed each day the Atomlab 930 is to be used. Separate calibrations are performed for the probe and well. The system keeps an internal listing of its last calibration date and will not allow measurement procedures to commence until this requirement has been met. Standard calibration may be performed from any of the Atomlab 930's six operating modes but the Chi-Square Test is accessed only through "Mode #6, Calibration". The Chi-Square Test runs automatically once started and the results print out upon request.

For the daily calibration, the system prompts the user through the calibration process for well or probe. The user, in the Calibration Mode Setup loop, determines if a manual time or automatic count mode is preferred. The count mode selected is automatically programmed into the system and is used for the entire calibration procedure. The results are numerically compared to a normal spectrum before calibration is accepted. A report can then be generated with calibration data and a graph of the spectrum. Full width at half maximum (FWHM) is determined by interpolation between the two immediate points above and below the 50% value of the spectrum peak on both sides of the peak. The difference between the two interpolated channel values is then divided by the channel of the peak itself and multiplied by 100% to arrive at FWHM. The peak is simply the maximum value in the spectrum.

Your Hospital Name
Address
City, State Zip
(000) 000-0000

Spectrum Report

DATE: Dec 01, 1993 TIME: 10:07



The above spectrum was collected under the following conditions:

Mode: Calibration - after calibration save

ID: N/A

Isotope: Cs-137

Detector: Probe

Gain: 2

Count type: Auto count time

Spectrum Analysis:

Peak: Energy = 661 keV; Count = 8395; Rate = 21899 cpm

ROI 1: Energy = 562 keV to 761 keV; Count = 115962; Rate = 302528 cpm

Total: Count = 310316; Rate = 809520 cpm

Count Time: 23 seconds.

Events above channel 256: 133 counts

S/N 871031 D4.0/M4.0

Figure 3. A sample Daily Calibration Spectrum report.

Your Hospital Name
Address
City, State Zip
(000) 000-0000

CHI - SQUARE REPORT

DATE: Dec 01, 1993 TIME: 09:56

ISOTOPE/ACTIVITY: CS-137 / _____

COUNT TIME PER INTERVAL: 10 seconds

DETECTOR: PROBE

INTERVAL #	GROSS COUNTS	
1	159744	
2	160213	
3	159509	
4	159445	
5	159594	
6	160021	
7	159701	
8	159253	L
9	159488	
10	160512	H
SUM	1597480	

PROBABILITY	CHI-SQUARE	
0.99	2.09	
0.95	3.33	
0.90	4.17	<lower limit
0.50	8.34	
0.10	14.68	<upper limit
0.05	16.92	
0.01	21.67	

RESULTS: PASSED CHI-SQUARE = 8.25 DEGREES OF FREEDOM = 9

Technologist:_____

Comments:_____

S/N 871031 D4.0/M4.0

Figure 4. A sample Chi-Square report.

If desired, you may perform additional calibrations on the same day. You need only calibrate the detector(s) that will be used. Detectors that will not be used at this time do not need to be calibrated. If desired, Daily Calibration can be bypassed in any of the six modes by pressing <Clear>. If the calibration procedure is bypassed, however, the system will not be calibrated and your reading may be incorrect. *Bypassing Daily Calibration is not recommended.*

The daily calibration Chi-Square Test and High Voltage Adjustment are performed using a 10 μCi Cs-137 button source. Once calibration is underway, the system's unique differential spectrometer automatically measures the peak height and subtracts the baseline which makes zero adjustment obsolete. It does this for 100,000 pulses and then plots the spectrum in internal memory. The peak channel is located and equated to 662 keV, which is the Cs-137 gamma energy. This gives the spectrometer the keV/channel which is used to calibrate all the other isotope gains. Each clinical isotope has an ROI defined with lower and upper energy limits. These energy limits are then converted to channels in the MCA when a particular isotope is counted. Corrections are made of NaI non-linearity. The spectrum of calibration, or any isotope, is available in hard copy by pressing <Spectrum>.

The multi-channel analyzer in the Atomlab 930 has several fixed precision gains and a regulated high voltage supply. The pulse shapes are digitized and then processed by a high speed digital signal processor. This processing results in a possible 256 pulse heights which has zero offset. A spectrum results when a histogram of these pulse heights (channels) is plotted. Calibration of the spectrometer is defined as knowing the energy equivalence of each channel. This is accomplished by determining the Cs-137 spectrum and then calculating the ratio of the 662 keV/peak channel. After calibration, the report should always print a peak value very close to 662 keV (some precision round-off may occur), and the change in calibration will be reflected in the keV/channel slope value. The fine gain can be thought of as a floating point numerical gain. The HV adjust will ultimately determine the maximum energy one can measure on the gain selected. It can be calculated by multiplying the printed keV/channel times 256.

The Chi-Square Test is independent of the counting time, counting rate, and number of counts performed. For this reason, Chi-Square is a very valuable test for a detector system which is recording truly random events. For example, if systematic failure occurs at low counting rates but passes at high rates, there is an indication of a non-random event occurring which is comparable to the low counting rates. Since time is precise to within 10 microseconds with a crystal controlled clock, 10 second count times should have very little error due to the timer itself.

The number of counts performed is 10, which determines the number of degrees of freedom (9) for the analysis. The lower limit is 4.168, the upper limit is 14.68. These correspond to a 90% probability for passing, and 10% probability for failing, respectively. In all, one would expect a 20% failure rate frequency for the Chi-Square test. It is not reasonable to always pass or always fail chi-square without raising concerns that there may be a systematic problem in the detector or counter.

Calibration Setup

At the "Mode #6 Calibration" prompt, press the flashing <Select> key to access the Calibration Mode. Now press <Setup> to enter the Calibration Mode Setup loop. In this loop you can:

- Set Count Time (Manual/Automatic)
- Select an isotope for high count rate correction
- Perform a High Voltage Adjustment
- Install or uninstall a well or probe

Press <Setup> to skip any parameter, or select the displayed parameter, and move onto the next prompt. Remember, the parameters listed above, except for Set Count Time, will be set for all modes. The count time setting will be for the Calibration mode only.

Set Count Time Procedure (Manual/Automatic)
The user can choose between setting the counting time manually or automatically. If manual counting is selected, the user inputs the actual count time in the traditional manner. If automatic counting is selected,

the Atomlab 930 sets the count time based on the actual count rate. The system requires 300,000 counts in automatic calibration to set the gain. During the first four seconds the number of counts is evaluated. Based on this sampling, the system then displays the automatic count time.

1. At the "Mode #6" prompt, press <Select> to access the Calibration Mode. Now press <Setup> to enter the Calibration Mode Setup loop. The display responds with a message stating the status of the count time, either manual or automatic.

2. If you changed the count time status, press <Setup> to record the new status. To proceed with the displayed status, press <Setup>. If you selected Manual, proceed to step #3. If you selected Automatic, skip to step #4.

3. If you have selected Manual as the count time status, the display will next prompt you to enter the Calibration Count Time in seconds. Enter the desired time and press <Save> to advance to the "High Count Rate Correction" prompt.

4. If you have selected Automatic as the count time status, the display will next prompt you to press <Enter> to set the Maximum Count Time or press <Setup> to skip. If you press <Enter>, the current maximum count time will be displayed. Press <Setup> to keep the maximum count time displayed or use the numbered keys to input a new maximum count time. Press <Save> to record a new count time and advance to the "High Count Rate Correction" prompt.

High Count Rate Correction

High Count Rate Correction allows compensation for peak broadening at high count rates. Essentially, the system determines the percent of total counts within the ROI, along with other ROI criteria including peak channel, so that compensation can be provided. This only occurs at count rates exceeding 1.2 million counts per minute (20,000 cps).

High count rate non-linearity Factor (NF) values are printed on the Power-Up and Self-Test reports. If high count rate correction is used, it will be noted on the Spectrum Report.

NOTE: *The system should be calibrated before performing the following procedure.*

To select an isotope for High Count Rate Correction:

1. Select the desired isotope for High Count Rate Correction.

2. Select Well or Probe.

3. Position source at detector. (Keep ROI CPM < 100,001 to avoid getting a "Count Rate is too high" error.)

4. Press <Count>. When finished, the system gives an ROI percentage for the isotope.

5. Press <Save> to record the percentage. You can now select another isotope if desired.

NOTE: *To keep the current isotope and advance to the "HV Adjustment" prompt without making a change, press <Setup>.*

Resetting High Count Rate Correction to Zero

To reset the high count correction value to zero:

1. From the Mode Selection Menu, prior to selecting any mode, press <Setup> to advance to the Change ROI prompt.

2. Select the isotope to be reset to zero for high count rate correction.

3. Press <Save> to save the current gain.

4. Press <Save> to save the current minimum keV.

5. Press <Save> to save the current maximum keV.

Using the above procedure causes the Atomlab 930 to believe that the ROI for the system has been modified. This prompts the 930 to automatically reset the high count correction to zero. At this point, the system returns to the "Change ROI" prompt. You may now press <Clear> to return to the Mode Selection Menu or continue on from the "Change ROI" prompt.

High Voltage Adjustment

High Voltage Adjustment should be performed only:

- If this is an initial setup or the system has been turned off for a substantial period of time
- If the system is to be used in a new environment or in the instance where a substantial environmental change has been made (i.e., when using a new probe)
- If the system has been moved
- If the system has been repaired and returned
- If you suspect there are problems with the system

NOTE: *If a probe and well are both used, then the high voltage adjustment must be set independently for each unit. The system must be ON and warmed-up prior to setting the high voltage.*

To bypass the High Voltage Adjustment:

1. Press <Setup>. The system advances to the "Well or Probe Installation" screen.

To perform a High Voltage Adjustment:

NOTE: *Before beginning this procedure, ensure that the system has been turned ON for at least two hours.*

1. At the "HV Adjustment" prompt, press <Enter>. The system prompts: "Are you sure?"

2. Press <Clear> to exit and advance to the "Well or Probe Installation" screen. Press <*> to continue.

3. Select <Well> or <Probe>. The system prompts you to position the 10 uCi (CS-137) button source source at the detector.

4. Press <Clear> to exit or <Count> to begin HV adjustment. If you choose to begin, the system responds with a message that the adjustment may take up to 10 minutes. When the High Voltage Adjustment is complete, the screen will display the probe or well HV DAC setting. This number will be 256 or lower.

5. Press <*> to advance to the "Well or Probe Installation" screen.

NOTE: *Throughout this option, the <Clear> key will flash, serving to remind the user that this procedure can be aborted at any time.*

Probe or Well Installation

Well or probe installation is a simple toggle. On the screen, the system displays the current status of each detector as being either "Installed" or "Not Installed". The probe status is displayed first.

To change the probe or well status:

1. At the probe status prompt, press <Enter>. The probe status listing changes from "Installed" to "Not Installed" or vice versa.

2. Press <Setup> to select the new status and advance to the well status prompt. Repeat the same procedure for the well. When you are finished, the <Setup> LED stops flashing and the system advances to the "Select Well or Probe" prompt. You are now ready to begin the calibration procedure.

Calibration Procedure (Includes Chi-Square)

NOTE: *Press <Clear> at any point in the calibration procedure to exit and return to the "Mode # " prompt without saving any new calibration data.*

The Calibration Procedure can be performed from any of three starting points:

- At the "Select Well or Probe" prompt displayed immediately after selecting Mode #6
- At the "Select Well or Probe" displayed immediately after completing the Calibration Setup loop
- At the initial daily calibration prompt in any mode (Chi-Square can be performed only in Mode #6)

NOTE: *For Daily Calibration, begin the following procedure at step #2. On power-up, the probe is selected as the default detector. Press <Clear> if you want to select the well instead. Proceed to step #3.*

1. Select well or probe.

2. Position the Cs-137 source at the collimator.

3. Press the flashing <Count> key to calibrate. The message "Counting standard..." displays, along with the actual count time in seconds. In the ROI (Region Of Interest) Box at the right of the display unit, current readings for ROI CPM (Counts Per Minute) and ROI counts are displayed.

   NOTE: *If counts are too high or too low, the system will prompt you to move the source either closer or further from the detector. After repositioning the source, press <Test> to continue.*

4. Press the flashing <Save> key to save the calibration. Press the <Count> key to redo the calibration. Once <Save> is pressed, the screen displays "Calibration is finished. Press <Spectrum> or <*> to continue". At this point, you should print the spectrum to verify that it looks correct.

5. If you are <u>not</u> in Mode #6 and elect to save the calibration, the screen will provide a message that the calibration is complete. Press <Spectrum> to print a spectrum, <*> to continue, or <Clear> to skip. If you choose to skip, you will need to calibrate the well before using it. The system now returns to the Mode # prompt. You may now proceed with measurements as explained in the following sections.

   If you are in Mode #6, the screen will next prompt for a Chi-Square Test. Press the flashing <*> key to begin, or press the <Clear> key to skip and return to the Mode #6 prompt.

6. To perform the Chi-Square Test, position the Cs-137 source and press the flashing <Count> key. The system begins the test and at completion, displays the results as "pass", "high" or "low". Press <Count> to redo or <Clear> to exit and return to the Mode #6 prompt. This test takes approximately two minutes to complete.

   NOTE: *To print the Chi-Square Test result, press the <Data> key.*

Your display at this point should once again show the Mode # prompt. You may now select the current mode or a new mode in which to operate. Simply press the <Up Arrow> or <Down Arrow> thumbwheel keys to scroll through your choices. The following section provides operating procedures and a description for each mode.

MODE #1: Thyroid Uptake Analysis

(See Figure 5)

In this mode, a radioactive uptake study is performed. The system guides the user through a step-by-step procedure that includes the counting of a standard, a patient's thyroid, patient background, and the computation of the uptake percentage. The uptake percentage can then be printed out on a form designed to provide complete information on the patient study. There are four options available in this mode:

Manual Count Time/ New Patient, Automatic Count Time/New Patient, Manual Count Time/Existing Patient, and Automatic Count Time/Existing Patient. Each is explained in the following section.

NOTE: *If you have not yet calibrated your Atomlab 930 on this day, the system will prompt you to calibrate before proceeding with the Thyroid Uptake or any other mode selected. Once the calibration is performed, the system will display the Enter Patient ID# prompt.*

Thyroid Uptake Setup

At the "Mode #1, Thyroid Uptake" prompt, press the flashing <Select> key. The system responds with an "Enter ID" prompt. Press <Setup> to access the Thyroid Uptake Setup loop, or skip the Setup loop and enter an ID number as explained later in the Thyroid Uptake Procedure.

If you enter the Thyroid Uptake Setup loop, you can:
- Set Count Time (Manual/Automatic)
- Set Patient Background Multiplier

Press <Setup> to skip any parameter, or select the displayed parameter, and move onto the next prompt. Remember, the parameters listed above will be set for "Thyroid Uptake" mode only.

Set Count Time (Manual or Automatic)
The user can choose between setting the counting time manually or automatically. If manual counting is selected, the user inputs the actual count time in the traditional manner.

If automatic counting is selected, the time period for each measurement becomes a variable. Measurement will continue until a predetermined accuracy is reached as determined by random counting statistics. For automatic measurements, statistical accuracy is user defined (i.e., 99%, 97%, 95%, etc.). The time is based on the level of radioactivity being measured, the background level, the type of measurement being made, and the user selected percent accuracy. Lastly, the system performs an internal check to ensure the count was accomplished with an acceptable degree of certainty. The level of accuracy is set or changed in the setup mode.

If automatic counting is selected, each count time for a thyroid uptake measurement is automatically determined, using counting statistics, by imposing an overall accuracy requirement on the uptake result. There are four count times which comprise an uptake measurement: Standard, Lab Background, Thyroid and Patient Background. Each count resulting from a lapsed count time has a statistical uncertainty which is related to the count. When these four independent counts are combined to yield the uptake value, the uncertainties must also be combined to yield the total uncertainty of the uptake. This total uncertainty is preset by the user, in the Uptake Setup loop, when the instrument is installed.

At the start of an uptake procedure, the total uncertainty is partitioned between the four count times in a rational way which minimizes the count times for all four counts and thereby minimizes the amount of time the patient must remain immobile. Because the count rate is high, the Standard count time is usually short. Time for the Lab Background is determined from the first few seconds of Lab Background counting. If the count rate is very low, the count time will be short because the net error of (Std,-Bkgnd.) contains only a term proportional to (Bkgnd. Rate/Std. Rate).

Thyroid count time is also determined during the first few seconds of Thyroid counting. It is calculated from the approximate Thyroid rate and the Standard count rate in such a way that the Thyroid measurement uncertainty will be only a fraction of the total target uncertainty. Finally, the Patient Background is determined during its first few seconds of counting with the requirement of the total uncertainty satisfying the accuracy goals.

Examples
The following academic numerical examples should provide some idea of the four required measurement times in actual practice. Each example assumes a user-selected counting accuracy requirement of 98%. This means that there is a 2% allowed counting error at the 90% confidence level. If you repeat each of the four measurements and calculate the uptake, nine out of ten results will fall within 2% of the first measurement.

NOTE: *You must select the accuracy requirement in the Uptake Setup loop. The factory setting is 95%, if you want 98% as illustrated in this example, you must select it. The counting times get longer with higher accuracy requirements.*

NOTE: *The "2%" uncertainty is only with respect to detector counting. If a measurement is "repeated" with repositioning of the standard or patient, there will be additional geometry setup errors which will add to the counting errors.*

NOTE: *The % uncertainty is not an uptake % but a percentage of the uptake. For example, if the uncertainty is 2% and the uptake is 50%, then the uncertainty is 2% of 50%, or ±1%, and the uptake range could be 49% to 51%. If the uptake was 10%, the uptake could be 9.8% to 10.2% (2% of 10% is 0.2%).*

Maximum Count Time

All of the following examples had a 60 second maximum count time set in the Uptake Setup loop. The first example did not require longer than 60 seconds on each measurement to satisfy the 98% accuracy requirement. The next two examples did require longer than 60 seconds on some of the measurements but the actual time was limited to 60 seconds automatically. The uncertainty resulting from such a shortened time is stated with the example.

Minimum Count Time

The minimum count time for any count in the uptake mode is 10 seconds. This is illustrated in all three examples during the Lab background count.

Example 1: I-123, 6 hour uptake, 98%, 60 sec max count time

	cpm	Actual Count Time	Computed Auto Time
Measured Standard	538,920	53 sec	53 sec
Measured Lab Bkgnd	64	10 sec	2.2 sec
Decayed Standard	(393468)	–	–
Measured Thyroid	108,060	29 sec	29 sec
Measured Pat. Bkgnd	7,500	12 sec	12 sec

Uptake = 25.6% ± 2% (25.1% to 26.1%)

Comment: The automatic time selection controlled the counting since all times were less than the maximum set count time of 60 seconds. The patient was required to remain in a counting position for only 29 seconds for the thyroid and 12 seconds for the background count. This is very beneficial for hyperthyroid and elderly patients. Plus the automatic count time mode takes less time to set up. The Uptake of 25.6% has a 2% uncertainty meaning it could be 25.1% to 26.1%.

NOTE: *In this example and the following two others, the "pill" was counted at the time of administration (Measured Standard) and the count rate was decayed to the time of the thyroid count (value in parenthesis).*

Example 2: I-123, 6 hour uptake, 98%, 60 sec max count time

	cpm	Actual Count Time	Computed Auto Time
Measured Standard	538,920	53 sec	53 sec
Measured Lab Bkgnd	64	10 sec	2.2 sec
Decayed Standard	(393468)	–	–
Measured Thyroid	36,000	60 sec	119 sec
Measured Pat. Bkgnd	12,000	60 sec	81 sec

Uptake = 6.1% ± 2.3% (5.96% to 6.24%)

Comment: The uptake was about one fourth the value as in example 1 in order to illustrate the change in counting time required for uptake and patient background. If the maximum set count time was 120 seconds, then the actual counting times for the thyroid and patient background would have been 119 and 81 seconds respectively. The standard and lab count rates were kept the same for demonstration purposes.
Note that even though the actual count times were lower than the required time for a 2% uncertainty, the times used (thyroid time almost 1/2 of the computed value) resulted in only an increase of 0.3% uncertainty. This is certainly not significant, particularly in view of the low uptake where count times will tend to be longer because of the lower count rates.

Example 3: I-123, 6 hour uptake, 98%, 60 sec max count time

	cpm	Actual Count Time	Computed Auto Time
Measured Standard	120,000	55 sec	55 sec
Measured Lab Bkgnd	300	10 sec	5.3 sec
Decayed Standard	(87612)	–	–
Measured Thyroid	12,000	60 sec	156 sec
Measured Pat. Bkgnd	3,600	60 sec	90 sec

Uptake = 9.6% ± 2.8% (9.33% to 9.87%)

Comment: In this example, we see much lower rates in the standard and thyroid counts. However, the standard count time only increased by 2 seconds. The reason for this is twofold. First, the equations for time computation derived from counting statistics are nonlinear. Second, pulse height analysis at the higher counting rates takes a longer period of time.

Note the increase in Lab background time. This is due to the increase in lab counting rate and how the standard and lab rates are treated in the analysis. The lab is subtracted from the standard. Any error in the lab is carried forward into the overall error, but the impact depends upon the relative counting rates. If the standard is 10,000 times higher than the lab, then a 50% uncertainty in the lab will only contribute a very small error to the difference. As the lab rate increases with respect to the standard, its error contribution will also increase which will require a more precise measurement of the lab.

The thyroid count time increased significantly but the actual count time again was only 60 seconds because of the maximum time set. Note the increase in the uptake uncertainty went to 2.8%, due to the reduction of actual counting times from time values which were required for the thyroid and patient background measurements.

Set Count Time Procedure (Manual/Automatic)

1. After selecting "Mode #1, Thyroid Uptake," press <Setup>. The display responds with a message stating the status of the count time, either manual or automatic.

2. Press <Setup> to keep the current count time status. Press <Enter> to change the count time status.

3. If you changed the count time status, press <Setup> to record the new status.

4. If you choose Manual go to #6. If you have selected Automatic as the count time status, the display will next prompt you to press <Enter> to set the maximum count time or press <Setup> to skip. If you press <Enter> the current maximum count time will be displayed. Press <Setup> or <Enter> to keep the maximum count time displayed or use the numbered keys to input a new maximum count time. Press <Save> to record a new count time.

5. The display next prompts the user to enter the % Accuracy desired. Press <Setup> to skip, or press <Enter> to view the current percentage and use the numbered keys to enter a new percentage. Press <Save> to record the new percentage. The system advances to the "Set Patient Background Multiplier" prompt. (You should make it a habit to review the % Accuracy while in the Setup loop. A higher accuracy value will reduce the error due to counting statistics.)

NOTE: *Only the right-hand % Accuracy digit will change since all percentages must be 90% or greater.*

6. If you have selected Manual as the count time status, the system will now display "Set Patient Background Multiplier."

Set Patient Background Multiplier
The Patient Background Multiplier is a number used to adjust high measurements to more accurately reflect patient background in the region of the thyroid. A standard default value of 1.000 is provided. The user can select from a range of 0.01 - 10.00.

To change the default Patient Background Multiplier:
1. Use the <Up> or <Down> arrow keys to change the default value to the desired number.

2. Press <Save> to save the new multiplier value, or press <Setup> to retain the current value. The system now returns to the Patient I.D.# prompt. You can now set or choose a new Patient I.D. #, or press <Setup> to advance to the Thyroid Uptake procedure.

NOTE: *The Patient Background Multiplier Number is based on usage by N. David Charkes, MD. Information is provided in the following sources: Radioactive Nuclides in Medicine and Biology, Third Edition, pps. 51 and 52; Textbook of Nuclear Medicine, Vol. 2: Clinical Applications, re: Thyroid Uptake; Clinical Tests of Thyroid Function, John A. Thompson, Chapt. 2.*

Thyroid Uptake Procedure

The Thyroid Uptake procedure can begin from either of two starting points:

- From the "Mode #1", Thyroid Uptake prompt
- From the "Enter ID" prompt if you have just finished the Thyroid Uptake Setup loop. For this option, begin the following uptake procedure at step #2.

CAUTION: *The capsule count and Lab background must be counted and saved before administering the capsule to a patient.*

Manual Count Time - New Patient
1. At the "Mode #1 Thyroid Uptake" prompt, press the flashing <Select> key.

2. The screen will prompt you to enter the Patient ID#. Enter a new patient ID# via the numbered keys. The I.D. # may be up to nine digits long. We suggest using the patient's Social Security Number. Press the flashing <Save> key after completing your entry, or press <Clear> if you've made a mistake and would like to re-enter the number.

3. Select the appropriate isotope key, position the Standard and press <Count>.

4. The screen will now prompt you to enter the Standard count time in seconds. Use the numbered keys to make your entry, then press the flashing <Save> key.

5. You are now prompted to position the standard for counting, press <Count>.

   NOTE: *Perform a Lab background immediately after counting the capsule. You must complete a Lab background before you can save the capsule counts.*

6. After counting the standard, the system will prompt the clinician to enter the Lab background count time in seconds. Enter the Lab Bkgnd count time then press the flashing <Save> key. The prompt, "Prepare for Lab background" now appears on the screen. Ensure that no sources are in the vicinity, then press the flashing <Bkgnd> key to start counting Lab background.

7. After the background key is pressed, the system will begin a Lab background count. When it has finished the message, "Standard, background complete" will be displayed on the screen. Press <Count> to redo the Standard count again, <Bkgnd> to remeasure the Lab background, or <Save> to save the data.

8. After the data has been saved the screen displays press <Data> to print or press <Clear> to skip. If you press <Data>, the patient ID# is displayed. You can now press <Save> to print the current patient, or use the <Up> and <Down> arrow keys to scroll to another patient and then press <Save> to print. After printing or clearing, the system returns to the Mode #1 prompt.

   NOTE: *You can print a spectrum immediately after completing any count by pressing the <Spectrum> key.*

Automatic Count Time - New Patient

1. At the "Mode #1 Thyroid Uptake" prompt, press the flashing <Select> key.

2. The screen will prompt you to enter the Patient ID#. Enter a new patient ID# via the numbered keys. Press the flashing <Save> key after completing your entry, or press <Clear> if you've made a mistake and would like to re-enter the number.

3. Select the appropriate isotope key, position the Standard and press <Count>.
   NOTE: *Perform a Lab background immediately after counting the capsule. You must complete a Lab background before you can save the capsule counts.*

4. The system will count the standard then prompt the technologist to "Prepare for Lab background". Ensure that no sources are in the vicinity, then press the flashing <Bkgnd> key to start counting Lab background.

5. After the background key is pressed, the system will begin a Lab background count. When it has finished the message, "Standard background complete" will be displayed on the screen. Press <Count> to redo the Standard count again, <Bkgnd> to remeasure the Lab background, or <Save> to save the data.

6. After the data has been saved the screen displays press <Data> to print or press <Clear> to skip. If you press <Data>, the patient ID# is displayed. You can now press <Save> to print the current patient, or use the <Up> and <Down> arrow keys to scroll to another patient and then press <Save> to print. After printing or clearing, the system returns to the Mode #1 prompt.

   NOTE: *You can print a spectrum immediately after completing any count by pressing the <Spectrum> key.*

Manual Count Time - Existing Patient

1. At the "Mode #1 Thyroid Uptake" prompt, press the flashing <Select> key.

2. The screen will prompt you to enter the Patient ID#. Use the <Bkgnd/Up Arrow> or <*/Down Arrow> keys to scroll though the patient ID's on record. Press the flashing <Save> key after selecting your entry, or press <Clear> if you've made a mistake and would like to select another number.

3. The system next prompts the user to press <*> to skip (the system then calculates the decayed activity of the original sample), or press <Count> (to count the current decayed activity of the standard). If you choose count, position the standard and proceed to step #4. If you press the <*> key skip to step #5.

4. If you press the <Count> key, the system will prompt you to enter the standard count time in seconds. Use the numbered keys to make your entry. Press <Save>, position the standard, then press the flashing <Count> key. The system will count the standard then prompt the clinician to perform another Lab background. Enter the Lab background count time in seconds and press <Save>. Prepare for Lab background and press the flashing <Bkgnd> key. The system begins the Lab background count. After the background count has been completed, you have the option of pressing <Count> to redo the Standard count again, pressing <Bkgnd> to remeasure the Lab background, or pressing <Save> to advance and continue with the thyroid uptake.

Your Hospital Name
Address
City, State Zip
(000) 000-0000

THYROID UPTAKE REPORT

PATIENT NAME:_____ ID: 123456789
DATE OF REPORT: Dec 07, 1993 REF. PHYS._____
TEST DATE: Dec 07, 1993 TIME: 12:49
ISOTOPE/ACTIVITY: I-123 / _____ TECH._____
COUNT RATE: 35616 cpm LAB BKG: 1873 cpm

Survey	Thyroid cpm	Patient Bkg cpm	Standard cpm	Results
1 (A)	7819	1655		0.1 Hour Uptake = 18.3%

Note: . Unless otherwise indicated below, the overall counting accuracy is >95% for (A) surveys.
. Survey 1 counting accuracy = 94.5 %

IMPRESSION:_____

Physician:_____ Date:_____

S/N 955050 D4.0/M4.0

Figure 5. A sample Thyroid Uptake Analysis report.

5. Using the numbered keys, you can now enter the Thyroid count time in seconds. Press the flashing <Save> key to confirm your entry.

6. Position the patient thyroid and press the flashing <Count> key. The system displays the study number and begins the thyroid count.

7. Once the count time is completed, the screen next prompts you to enter the Patient Background count time in seconds. Use the numbered keys to make your entry and press <Save>.

8. Position the patient for a patient background measurement and press the flashing <Bkgnd> key. The message "Counting Patient Background" appears on the screen. When the counting is finished, the system concludes and displays the uptake data.

9. At this point, the user can press <Count> to count the thyroid again, <Bkgnd> to perform another patient background reading, or <Save> to save the currently displayed uptake data.

10. If you would like to save the data displayed, press the flashing <Save> key. The system records the current information, then prompts the user to print.

11. After the data has been saved the screen displays press <Data> to print or press <Clear> to skip. If you press <Data>, the patient ID# is displayed. You can now press <Save> to print the current patient, or use the <Up> and <Down> arrow keys to scroll to another patient and then press <Save> to print. After printing or clearing, the system returns to the Mode #1 prompt.

    NOTE: *You can store up to four studies per patient (maximum twenty-five patients). You can print a spectrum immediately after completing any count by pressing the <Spectrum> key. If more than four studies are attempted, the message "No more uptakes can be saved for this patient, <Clear> to exit " is displayed.*

Automatic Count Time - Existing Patient

1. At the "Mode #1 Thyroid Uptake" prompt, press the flashing <Select> key.

2. The screen will prompt you to enter the Patient ID#. Use the <Bkgnd/Up Arrow> or <*/Down Arrow> keys to scroll though the patient ID's on record. Press the flashing <Save> key after completing your entry, or press <Clear> if you've made a mistake and would like to re-enter the number.

3. The system next prompts the user to press <*> to skip (the system then calculates the decayed activity of the original sample), or press <Count> (to count the current decayed activity of the standard). If you choose count, position the standard and proceed to step #4. If you press the <*> key skip to step #5.

4. If you press the <Count> key, the system will prompt you to position the standard and press <Count>. It will then count the standard and prompt the clinician to perform another Lab background. Prepare for Lab background and press the flashing <Bkgnd> key. The system begins the Lab background count. After the background count has been completed, you have the option of pressing <Count> to redo the Standard count again, <Bkgnd> to remeasure the Lab background, or <Save> to advance and continue with the thyroid uptake.

5. Position the patient thyroid and press the flashing <Count> key. The system displays the study number and begins the thyroid count.

6. Position the patient for a patient background measurement and press the flashing <Bkgnd> key. The message "Counting Patient Background" appears on the screen. When the counting is finished, the system concludes and displays the uptake data. At this point, the user can press <Count> to count again, <Bkgnd> to perform another background reading, or <Save> to save the currently displayed uptake data.

7. If you would like to save the data displayed, press the flashing <Save> key. The system records the current information, then prompts the user to print or skip the printing.

8. To return to the the Mode #1 prompt without printing a hard copy report, press <Clear>. To print a hard copy report, press the flashing <Data> key. The system will display the current Patient ID#. You can now print out a report for the current patient, or use the <Up Arrow> and <Down Arrow> keys to scroll through the list of patient ID's and select another patient on which to report. In either case, press the <Save> key when you have selected the patient and wish to generate the report. After printing the report, the system returns to the Mode #1 prompt.

   NOTE: *You can print a spectrum immediately after completing any count by pressing the <Spectrum> key.*

Print Existing Patient Reports

1. At the "Mode #1 Thyroid Uptake" prompt, press <Data>. The system displays the first entry on the patient list at the 24-hour time.

2. Use the <Bkgnd/Up Arrow> or <*/Down Arrow> keys to scroll through the patient ID# list until the desired patient is displayed.

3. Press <Save> to generate a printed report. The system returns to the Mode #1 prompt.

Deleting a Patient

To delete a patient or patients from the patient list:

1. At the "Mode #1 Thyroid Uptake" prompt, press <Clear>. The system displays the first entry on the patient list.

2. Use the <Bkgnd/Up Arrow> or <*/Down Arrow> keys to scroll through the patient ID# list until the patient to delete is displayed.

3. Press <Enter>. A "Y" for "yes" appears next to the "DEL:" prompt at the right side of the screen, indicating the patient is tagged for deletion.

4. If you wish to delete more than one patient, use the <Bkgnd/Up Arrow> or <*/Down Arrow> keys to scroll through the list. Mark additional patients for deletion in the manner described above.

5. Once you have marked all the patients to be deleted, press the <Clear> key. The system will prompt the clinician to press <*> to delete the marked patient(s) or <Clear> to abandon and return to the "Mode #1 Thyroid Uptake" prompt without deleting.

To Remove A Patient From A full Database After A Study Has been Started

The maxium number of patients that can be stored in the Atomlab 930 Patient Database is 30. Once the database is full, the system will not save any more patients unless some are deleted to make more room. If the database is full, any patient you try to add could be lost when you save. Thus, it may be necessary to use the following procedure, from time to time, when reviewing the patient information prior to saving a new study.

The normal procedure for a study is to take the count, take the Background, and then press <Save>. Pressing <Save> prompts the system to check for room in the database. If the database is full, the following message is displayed:

"Max patients stored.
Press * to delete and CLEAR to abandon."

At this point, you can press <Clear> to clear out and abandon the study you have just counted and tried to save. Do this only if you have NOT yet administered the capsule to the patient and you wish to go back and selectively remove patients from the database. After pressing <Clear> you will have to re-enter the new patient number, count the source and Background, and press <Save> again.

Alternatively, you can press <*> to delete. Pressing this key brings up the patient database, allowing patients to be removed and the study just completed to be saved.

MODE #2: Employee Bioassay

(See Figure 6)

This mode is used to verify any Iodine-131, 123 or 125 concentration for staff who have direct contact with radioactive Iodine or patients. A record may then be printed out with a listing by ID # for those who have had a Bioassay count.

Bioassay Setup

At the "Mode #2, Employee Bioassay" prompt, press the flashing <Select> key. The system responds with an "Enter Lab background" prompt. Press <Setup> to access the Bioassay Setup loop, or skip the Setup loop and proceed as explained later in the Employee Bioassay Procedure.

If you enter the Bioassay Setup loop, you can:

- Select an employee from the employee list, Enter a new employee with ID number, or Delete an employee

Any additions or deletions you make to the Employee Bioassay List will be used in the Bioassay Mode only.

Press <Setup> to select the currently displayed employee and proceed with the Employee Bioassay Procedure or you can enter/delete an employee as explained below.

Enter (or Delete) Employee ID #

Employee ID# and name are used to identify Bioassay studies and reports. The system sets up for one of the three iodines when engaged in bioassay work.

At this point, the system displays the oldest (least recent entry) employee. You can now select the employee displayed as explained above, enter a new employee, or delete an employee.

To enter a new employee:

1. Use the <Bkgnd/Up Arrow> or <*/Down Arrow> keys to advance to the blank employee screen. If the screen is currently blank, proceed to step #2.

2. Press <Enter>.

3. Use the number keys to enter the employee ID number. The system is designed to accept a Social Security number but will accept any entry up to nine digits. Press <Save> when complete.

4. Enter the employee name in the same manner as you entered the facility title (using the ASCII format by choosing the appropriate letters from the display).

5. To save, press <Save> or use the <↵> symbol. You can now enter additional employees or continue.

6. Press <Setup> to advance to the "Enter Lab background" prompt. The system is now ready to begin the Employee Bioassay procedure.

To delete an existing employee:

1. Use the <Up Arrow/BKGND> or <*/Down Arrow> key to scroll though the employee list until the desired employee is displayed.

2. Press <Enter>. A "Y" for "yes" appears next to the Del: prompt at the right side of the screen, indicating the employee is tagged for deletion.

3. Press <Clear>, if you wish to delete the marked employee or, press <Setup> to advance to the "Enter Lab Background" prompt and begin the Bioassay procedure without making a deletion.

4. If you choose <Clear> to delete the employee, the system will prompt you to press <*> to delete the employee or <Setup> to skip. If you choose to delete, the system will advance to the "Enter Lab background" prompt and the employee will be deleted. The system is now ready to proceed with the Bioassay procedure.

Your Hospital Name
Address
City, State Zip
(000) 000-0000

BIOASSAY TEST REPORT

DATE: Dec 07, 1993 TIME: 12:58

Detector: Probe
Date: Dec 07, 1993 Time: 12:56
Lab background count time: 5 seconds
Employee Count Time: 5 seconds

Name	ID#	Isotope	ROI Rate Thyroid cpm	- Lab cpm	= Net cpm	SD σ cpm	Net/σ	Advised Action
LL	2	I-131	348	360	-12	-92	0.13	None

Statistical Meaning	Background changed	NO CONTAMINATION	CONTAMINATION
Net/σ	-3	0	2

Technologist:_____

Comments:_____

S/N 955050 D4.0/M4.0

Figure 6. A sample Employee Bioassay report.

Employee Bioassay Procedure

The Employee Bioassay procedure can begin from either of two starting points:
- From the "Mode #2", Employee Bioassay prompt
- From the "Enter Lab background" prompt if you have just finished the Employee Bioassay Setup loop. For this option, begin the following uptake procedure at step #2.

To perform an Employee Bioassay:
1. At the "Mode #2 Employee Bioassay" prompt, press the flashing <Select> key. The screen will prompt you to enter the Lab count time in seconds. Use the numbered keys to enter the Lab count time. Press the flashing <Save> key after completing your entry, or press <Clear> to start over again.

2. The system next prompts the user to prepare for a Lab background. Press the flashing <Bkgnd> key. The screen will display, one at a time, the lab count for I-123, I-125 and I-131.

3. Following the Lab background count, use the numbered keys to enter the employee count time in seconds. Press the flashing <Save> key to confirm your entry.

4. The screen now displays the name of the current employee and the employee status in terms of having completed a bioassay on the highlighted isotope since entering this mode, (Done or Not Done). At this point, you can press either flashing isotope key to change from the current isotope or continue on with the current isotope selected.

5. Having selected or confirmed the isotope, press the flashing <Enter> key to select the patient displayed, or use the flashing <Bkgnd/Up Arrow> or <*/Down Arrow> keys and scroll through the employee list to make another selection. At this point, you can also press the flashing <Save> key followed by the <Data> key to print the background and return to the Mode #2 prompt or <Save> followed by <Clear> to skip the report and return to the Mode #2 prompt.

   NOTE: *For multiple employee studies, background is counted only once. When you go to the mode prompt, you must re-enter background before doing a bioassay.*

6. Once the employee has been selected, the system prompts the technologist to position the employee and press <Enter>. Following the count, the system displays the bioassay data in the lower right portion of the screen. The employee status is now listed as "Done".

7. After completing an employee's bioassay for one isotope, the system offers three options:
   - Press the flashing <Enter> key to recount the employee
   - Press the flashing <Up Arrow> or <Down Arrow> key to scroll through the list of existing employees and select another employee for a count by pressing <Enter>
   - Press the flashing <Save> key, followed by <Data>, to generate a report for all the employees just tested or <Save> followed by <Clear> to skip the report and return to the Mode #2 prompt

   NOTE: *You can print a spectrum immediately after completing any count by pressing the <Spectrum> key.*

   NOTE: *The standard deviation for Lab background displayed on the Bioassay report is determined by calculating the square root of the I-131 ROI counts in the Lab background before the worker is measured. If the employee count in I-131 ROI is greater than 2 standard deviations from the Lab background in I-131 ROI, it will be indicated on the display. If not, there is no significant contamination. Standard deviation for I-123 and I-125 are computed similarly.*

   If the count is greater than 2 sigma, there is contamination but it has not been quantified. To quantify the contamination, the employee can be counted as an uptake patient and uptake simulated without actually administering the pill.

   If the count is less than 3 sigma, the Lab background has probably changed and should be repeated.

MODE #3: Wipe Test

(See Figures 7 and 8)

NOTE: *For Wipe Test, the activity shown is NET activity. This means that the background count is subtracted from the count before the activity is calculated. For all other modes, counts shown are the actual counts detected and are not netted for background.*

The Wipe Test mode is used to determine the DPM or μCi's of swipes taken in the designated areas of a department. A total of 10 swipes may be identified and counted per area. A report of the Wipe Test results for all areas are then printed out with each test identified by the number and result.

The detector efficiency calculation is performed in manual mode after the standard has been counted and is equal to the standard's cpm/dpm, where CPM is the standard's count rate and DPM is the standard's activity (entered as nCi and converted using 1 μCi $= 2.22 \times 10^6$ DPM). The counts are taken in the ROI of the isotope selected and a Lab background is subtracted from the wipe.

In order to verify the wipe test results, the standard can be measured as a wipe and the reported contamination should equal the value which was given as the standard activity. The geometry must be identical in both cases.

Wipe Test Setup

To access the Wipe Test Setup loop, at the "Mode #3, Wipe Test" prompt, press the flashing <Select> key. The system prompts to "prepare for Lab Background". Press <Setup> to enter the Wipe Test Setup loop or press <Bkgnd> to count the background and proceed directly to the wipe test procedure.

In the Wipe Test Setup loop you can:

- Select well or probe
- Set Geometric and Detector Efficiency
- Enter a custom isotope and set trigger level and ROI values
- Define areas, set regulatory limits, and select isotopes to be counted
- Print an area summary report
- Check or set isotope efficiency
- Set both lab and wipe restricted and unrestricted count and recount times
- Check LLD

NOTE: *For all Wipe Test Setup loop selections, pressing <Setup> keeps the current value and advances the system to the next setting prompt.*

Select Well or Probe

Upon entering the Wipe Test Setup loop, the user is first instructed to select either Well or Probe. If only the well or only the probe is installed, proceed to Set Geometric Efficiency, below.

To select the well or probe:

1. Press <Setup> to keep the current selection, or press the <Well> or <Probe> key to change the current selection.

Set Geometric Efficiency

Having selected the well or probe, the system displays a Geometric Efficiency value. To keep the current value, press <Setup> or <Save>.
To set a new Geometric Efficiency value:

1. Use the numbered keys to edit the current value. Press <Save> to save the new value entered or press <Clear> to return to the previous displayed value and start over.

NOTE: *There are two efficiency values defined in the Atomlab 930 Wipe Test Function: Geometric and Detector.*

Geometric efficiency, “GE”, is defined as the percentage of radiation emitted by the wipe which is intercepted by the detector. Any value between 0 and 100% is valid, but 0 and 100% are improbable.

Detector Efficiency, “DE”, is a composite number which allows conversion from detector counts to disintegrations. It is affected by three factors:

- The photon intensity in the isotope decay scheme defines the number of photons which are emitted per 100 disintegrations of the isotope. This number can be less than or greater than 100% as exhibited by Cr-51 (~10%) and Co-60 (~200%).

- The photon interaction in the detector will produce counts which integrate to a fraction of the total number of photons passing through the detector. This will always be less than 100% and will depend upon the detector crystal geometry and the photon energy.

- The ROI setting in the MCA determines the fraction of the MCA counts which are accumulated. Normally the ROI is adjusted around the photo peak, however, there can be several photon energies which are not included in this ROI because they may have a low emission intensity or their energies may cover a range too broad to be practical for background subtraction.

The Atomlab uses these two efficiency values to calculate disintegration rate with the following equation:

Disintegration Rate = Count ROI Rate / (GE * DE)

NOTE: *The efficiency values are discussed in the context of percent, and are entered into the Atomlab 930 as a percent, but their application in converting cpm to dpm uses a normalized form (i.e., DE/100 and GE/100).*

Geometric Efficiency Calculation

The value for GE is calculated from the following equations for a well and probe.

WELL:

$$G.E._{WELL} = \frac{1}{2}\left(1 + \frac{1}{\sqrt{1+\left(\frac{ID}{2X}\right)^2}}\right) * 100\%$$

ID = Inner diameter of the well opening
X = Depth into the well, measured from the top surface

For example, the Biodex NaI well dimensions have an ID = 0.75 inches and a well depth of 1.432 inches. When the wipe (or calibration source) is placed in the well, the isotope emitting radiation will not be at the very bottom. If we take the isotope position to be 1 inch from the top, then GE = 96.82%. (For X = 1.25 inches deep, GE = 97.89%; X = 0.75 inches, GE = 94.72% which are +1.07 and -2.1% respectively from 1 inch.)

PROBE:

$$G.E._{PROBE} = \frac{1}{2}\left(1 - \frac{1}{\sqrt{1+\left(\frac{OD}{2X}\right)^2}}\right) * 100\%$$

OD = Outer diameter of the probe
X = Distance from the end of the probe to the wipe

For example, the Biodex NaI probe OD = 2 inches. When the wipe (or calibration source) is placed 1/2 inch from the probe, then GE = 27.6%. (For X = 0.25, GE = 37.9%; X= 0.75, GE = 20%.)

From these two examples, we see that the well is at least 4 to 5 times more efficient for wipe test counting than the probe and is less dependent upon wipe positioning errors.

Detector Efficiency

DE can be calculated theoretically from system parameters or can be empirically determined by measuring the count rate from a known activity of each isotope. The empirical method results in a composite value (GE * DE) which can be reduced to DE by dividing by the calculated value for GE. Only the empirical method will be discussed below. The theoretical (analytic) method is also provided following an example calculation.

Empirical Efficiency Values for Wipe Testing

All isotopes for which wipes are to be counted shall either be prepared from a known liquid concentration or if possible, a standard source can be purchased in a wand form from various manufacturers. Generally, the isotopes Cs-137, Co-57, Co-60, Ba-133, and Am-241 are available in wand form with a stated activity and uncertainty. The activity should be kept in the range of 0.01 to 0.1 μCi, and should not exceed 0.2 μCi. This will generally keep the overall counting rate below 10,000 cps and will eliminate any spectrum distortion or non-linearity from playing a role in the efficiency calculation.

A suggested procedure for source preparation is outlined below. The liquid source will be deposited on an absorbent material in the bottom of a plastic vial which fits inside the well. It is recommended that no more than 10 ul of liquid be dispensed in order to reduce spilling radioactive material.

NOTE: *If a probe is being tested for efficiency, a method for holding the source or vial in proximity to the probe, approximately 1 cm, must be arranged. Then use the following procedure with modification as needed. If a distance greater than 1 cm is used, increase activity according to the Inverse Square Law.*

Source Preparation:

1. Prepare an activity of 0.1 to 0.01 mCi of the isotope in 10.0 ml of saline. This will result in a concentration of approximately 0.01 to 0.001 μCi/ul. The volume should be either controlled as close as possible to 10.0 ml or precisely measured.

2. Assay the activity in the vial in a dose calibrator which has a resolution of 0.01 μCi. Compensate for background before making the measurement. Record the time of measurement.

3. Calculate concentration by dividing the measured activity by the source volume and record with the time of measurement. Record concentration in units of μCi/ul (i.e., 0.01 mCi/ml = 0.01 μCi/ul).

4. Prepare the vial with absorbent material (such as a portion of a wipe pad or the end of a Q-tip) at the bottom of the vial.

5. Using a 10 ul syringe (see note), draw off source material and carefully place the end of the syringe tip at the bottom of the vial. Deposit 10 ul of source material onto the absorbent material.

6. Withdraw the syringe and immediately rinse it in saline at least ten times. This will reduce the chance of contamination of the next source which will be a different isotope.

7. Record the activity in the test vial in units of μCi as $A_{Xx\text{-}123}$ at time T as recorded in step 2. (The Xx-123 subscript is meant to designate the isotope symbol which should be recorded, i.e. Am-241.)

NOTE: *A tuberculin syringe is not suitable in this procedure. Hamilton microliter syringe, model 701-N, has a capacity of 10 ul with 0.2 ul resolution and will provide the necessary precision. Hamilton Co., P.O. Box 10030, Reno, Nevada, 89520. 800-648-5950.*

After the source preparation, the efficiency can be measured by counting the source in the MANUAL MCA MODE (mode 5) of the Atomlab 930. The OTHER key should be programmed with the gain and ROI values which are printed for the prepared isotope in the wipe test isotope list. The following steps should be followed.

Efficiency Measurement

1. Program the OTHER key for correct gain and ROI.

2. Perform a 100 second background count with an empty well. Print the spectrum. Record ROI counts as B.

3. Perform a 100 second count with the prepared source in the well. Print the spectrum. Record ROI counts as S. (This may also be a purchased wand source with a known activity and date of calibration.)

4. Calculate the composite efficiency DE * GE using the following equation.

$$D.E. * G.E. = \frac{\frac{(S - B)_{counts}}{100_{sec}}}{A_{\mu Ci} * 37000_{dps/\mu Ci} * 2^{\frac{(T-t)}{T_{1/2}}}} * 100\%$$

S and B are defined in steps 2 and 3 under Efficiency Measurement.

A is the activity determined in step 7 under Source Preparation for isotope Xx-123 with units of microcurie.

Exponent of "2":

This is a decay correction. For short lived isotopes such as Tc-99m, it is important. For long lived isotopes such as I-125, it may not be important unless the source is saved for future efficiency checks.

$T_{1/2}$ is the half life of isotope Xx-123, in units of h, days, etc.

T and t are respectively the time of source measurement in the dose calibrator and the time of counting the source in the well detector. Both should have the same units as $T_{1/2}$. For example, if T = 08:31 h and t = 15:49 h, then T - t = -7.300 h. If $T_{1/2}$ = 3.261 days for Ga-67, then T - t should be converted to days = -0.3042 days. In this case, the decay result would be 0.937.

5. Calculate DE from the composite (DE * GE) found in step 4 above and from the calculated value of GE found earlier in the discussion on GEOMETRIC EFFICIENCY. The following equation defines the calculation.

$$D.E. = \frac{(G.E. * D.E.)}{G.E.} * 100\%$$

Note that the two terms (DE * GE) and GE are both calculated as percents in the earlier expressions and the above result preserves DE as a percentage.

Example Calculation:
Determine the detector efficiency of Am-241 in a well detector with an opening of 0.625 inches and the source located in the well at 1 inch below the surface.

Geometric Efficiency for a Well: ID = 0.625 inches
X = 1.00 inch

GE = 97.7% (see earlier example)

Detector Efficiency for Am-241: A = 0.095 μCi @ T = 8/15/84
$T_{1/2}$ = 432.2
t = 5/1/93 (date counted in well)

OTHER was programmed for gain of 12 and an ROI of 50 to 69 keV.

100 second counts resulted in the following:
S = 99,403
B = 83

Now calculate the individual parts of the equation for (DE * GE)

Count rate = (S-B)/100 s = 993 cps

Disintegration rate = $A_{\mu Ci} * 37000_{dps/\mu Ci}$ = 3515 dpm

Decay Correction = $2^{(T-t)/T_{1/2}} = 2^{(84.71\ y - 93.42\ y)/432.2\ y} = 0.986$

DE * GE = 0.286 * 100% = 28.6%

DE = {(DE * GE)/GE} * 100% = (28.6/97.7) * 100 = 29.3%

We should now check our result for common sense. The photon emissions from Am-241 are 59.5 keV at 35.9% intensity and 26.3 keV at 2.4% intensity. The interaction probability for a 60 keV photon is very high in the Nal detector (Nal thickness on sides and bottom is about 0.625 inches), the bulk of this interaction will be photoelectric which puts most of the counts recorded in the photo peak. The ROI is set to integrate the photo peak of 59.5 keV. Therefore we would expect a detector efficiency to be a little less than photon intensity at 59.5 keV which it is.

Example of a Well Compared to a Probe for Counting Efficiency

If we assume the following parameters:

Isotope: Cs-137
DE Probe: 9.86%
DE Well: 13.47%

GE Well: 96.816% for a source placed 2.54 cm's deep in the well
GE Probe: 0.278% for a source placed 21 cm's in front of the probe

Probe:

DE * GE = 993 cps * 100% = 0.286 * 100% = 28.6% (3515 dps)(.986)

DE * GE = 9.86% * 0.278% = .02741%

Well:

DE * GE = 13.47% * 96.816% = 13.04%

A.) If the detector counts 54 cpm that is equivalent to the following dpm for the parameters listed above.

Probe: 54 cpm / .02741% = 197,008 dpm

Well: 54 cpm / 13.04% = 414 dpm

The detector efficiency "DE" is a composite number which allows conversion from detector counts to disintegrations for a given isotope. Three factors affect it:

1. The photon intensity in the isotope decay scheme defines the number of photons which are emitted per 100 disintegrations of the isotope. This number can be less than or greater than 100% as exhibited by Cr-51 (~10%) and Co-60 (~200%). The photon energy and percent abundance in the decay scheme can be found in "Table of Radioactive Isotopes" by Edgardo Browne and Richard B. Firestone, pub John Wiley & Sons, 1986, ISBN 0-471-84909-X.

2. The photon interaction in the detector will produce counts which integrate to a fraction of the total number of photons passing through the detector. This will always be less than 100% and will depend upon the window thickness which the photon detector must pass through, detector crystal geometry and the photon energy. This photon interaction has been calculated using "NaI (TL) SCINTILLATION DETECTORS", published by Bicron, manufacturer of the probe and well detectors. This publication contains two sets of curves which were used in the calculation of detector efficiency: Figure 14 "Absorption Efficiency of NaI (TL)" for various thicknesses of NaI, and Figure 17 "X-Ray and Gamma Transmission Through Bicron Detector Windows" for various window thicknesses.

3. The ROI setting in the MCA determines the fraction of the MCA counts which are accumulated. Normally the ROI is adjusted around the photo peak, however, there can be several photon energies which are not included in this ROI because they may have a low emission intensity or their energies may cover a range too broad to be practical for background subtraction. The photo peak contribution to the photon calculation in the NaI crystal was calculated using "GAMMA-RAY ABSORPTION COEFFICIENTS FOR ELEMENTS 1 THROUGH 100 DERIVED FROM THE THEORETICAL VALUES OF THE NATIONAL BUREAU OF STANDARDS", published by Los Alamos Scientific

Laboratory of the University of California, Los Alamos, New Mexico, Pub # LA-2237.
The Detector Efficiency (DE) has been calculated for both probe and well detectors. There is a difference because the photon path length through the NaI detector is different in the two detector configurations. There are some isotopes that the well efficiency has not been analytically determined due to gamma ray summing in the well. You must use the empirical method for these isotopes. You may have to create a custom version of the isotope with a different ROI to properly count the isotope in the well.

Select an Isotope

Having set GE, the system displays the first of five custom isotopes and associated data. At this point, it is necessary to set the custom isotope information if you have any custom isotopes.

NOTE: *You cannot change the ROI's for the 25 preset isotopes. You must set up a custom isotope if you want a different ROI.*

To skip custom isotope setup:

1. Press <Setup>. The system advances to the Area 1 setup prompts.

To select a Custom Isotope:

1. Use the <Up> and <Down> arrow keys to scroll to the custom isotope number you wish to view, set or change and press <Enter>. Press <Enter> to rename or <Setup> to skip the name and enter the ROI.

2. After reaching the "Custom Isotope Name:" prompt, use the <Bkgnd/Up Arrow> or <*/Down Arrow> keys to scroll though the ASCII list of letters, numbers and symbols to enter the name. The letter above the arrow pointer on the display will change with each press of the key. There is a set of lower case letters, upper case letters, numbers 1-0 and useful symbols.

3. To select any character or letter above the arrow pointer on the display, press <Count/Enter>. The selected character moves to the left and a new character appears above the pointer arrow.

4. Press <Count/Enter> to select the next character if it is correct, or scroll through the ASCII list until the appropriate character is displayed, and then press <Count/Enter>. Continue until you have entered the desired isotope name.

5. Set the ROI's minimum keV for the custom isotope. Use the <Up> and <Down> arrows to adjust the displayed minimum keV to the desired level. Press <Save> to save the desired minimum keV.

6. Having set the minimum keV for the custom isotope, it is now necessary to set the maximum ROI's keV following the same procedure.

7. The restricted area is now shown with the DPM level displayed. To change the DPM level press <Enter>. The <Enter> key serves as a toggle between 2,000 and 20,000 DPM. Press <Setup> to select the desired DPM and return to the custom isotope scroll screen where you can select another isotope if desired or press the flashing <Setup> again to advance to the Wipe Area Selection screen.

   NOTE: *Setting a restricted area of 20,000 DPM corresponds to an unrestricted area of 2,000 DPM. Setting a restricted area of 2,000 DPM corresponds to an unrestricted area of 200 DPM. See your regulatory guide for a discussion on restricted and unrestricted areas.*

Wipe Area Setup

1. At the Wipe Area Setup prompt, use the <Up> or <Down> arrow keys to scroll to any of the 10 areas for which you would like to enter or modify information.

2. With the desired area displayed, press <Enter>. The screen now displays three types of areas: restricted, unrestricted and sealed source.

3. Use the <Up> and <Down> arrows to scroll between the three wipe area types until the desired choice is displayed. Press <Save> to save the displayed area type.

4. Using the <Up> and <Down> arrows, set the percentage of regulatory limit (Trigger Level) desired. For example, if the restricted area has a regulatory level of 2,000 DPM's for a particular isotope, you can set the Trigger Level at either a lower or higher percentage of the regulatory level (i.e., 50% or 150% of the regulatory limit). Press <Save> to save the new trigger level.

Selecting the Isotope To Count in the Desired Area

NOTE: *You may select up to six isotopes per area. For initial setup, the isotope list is blank.*

1. Use the <Up> and <Down> arrows to scroll through the isotope list. (For initial setup, select isotope 1, area 1.)

2. To choose an isotope, press <Enter> to access a list of available isotopes. Now use the <Up> and <Down> arrow keys to scroll through the isotope list and find the isotope desired.

3. To select and save the displayed isotope as isotope 1 in area 1, press <Save>.

4. Use the same procedure to select isotopes #'s 2-6 if required.

5. To remove an isotope from the isotope list, display the desired isotope # and press <Enter>. Use the <Up> and <Down> arrow keys to advance to the blank isotope name prompt and press <Save>.

   NOTE: *If you just wish to change the listed isotope, enter a new isotope name at the blank isotope name prompt and press <Save>.*

When all areas are set, press <Setup> then <Data> to print an Area Summary Report showing a listing of each area, trigger levels, type of area and isotopes for that area, or <Setup> to continue without printing.

Enter the Detector Efficiency

Once all areas are set, Detector Efficiency for each selected isotope chosen for wipe testing can be displayed, set or changed.

1. Use the <Up> and <Down> arrows to scroll through the isotope list. To change the Detector Efficiency for any isotope, display the isotope desired and press <Enter>.

2. Use the # keys to enter the Detector Efficiency value and press <Save>.

   NOTE: *If you make a mistake while entering an efficiency number, press <Clear>. The system will allow you to re-enter the number as long as you haven't pressed <Save>. If you have already saved, just re-enter the isotope of interest and reset the efficiency.*

3. You can now scroll through the remaining isotopes and set corresponding efficiency values for each. Press <Setup> to continue after all detector efficiency values have been set.

   NOTE: *Determining detector efficiencies is explained earlier in this chapter starting under the heading "Mode #3, Wipe Test."*

Analytically Determined Detector Efficiencies

Refer to the accompanying table for Analytically Determined Detector Efficiency (%) for the Atomlab 930. These values reflect the istopes interaction with Sodium Iodide. You must use this detector efficiency number with the geometric effciency number. Multiply DE x GE to get the total system efficiency for the selected isotope. The result is the number to enter in the Atomlab 930 as detector efficiency.

Isotope	Left-ROI	Right-ROI	Probe Efficiency (%)	Well Efficiency (%)
Na-24	1162	3167	7.8	——
K-42	1296	1754	0.9	0.4
Cr-51	272	368	6.7	4.5
Co-57	103	158	93.8	92.8
Co-58	434	933	24.1	——
Co-60	997	1533	14.2	——
Fe-59	934	1486	7.7	3.8
Ga-67	79	345	72.8	——
Se-75	102	461	148.9	——
Sr-85	437	591	32.6	18.2
Tc-99m	119	162	84.3	82.3
Pd-103	17	27	62.3	62.3
In-111	145	281	163.4	138.7
I-123	134	183	79.5	75.4
I-125	23	41	133.5	133.5
I-131	309	420	47.4	30.1
Ba-133	256	410	60.8	——
Cs-137	561	761	18.2	9.7
Yb-169	41	228	312.4	——
Ir-192	250	703	124.6	——
Hg-197	56	90	89.1	89.1
Hg-203	237	322	62.8	44.8
Ti-201	57	96	93.2	——
Au-198	349	474	46.4	28.0
Am-241	50	69	35.7	35.7

Revised 7/95

NOTE: *It is recommended that users use the Empirical testing procedures for setting detector efficiency.*

Enter Count Times

1. Press <Enter> to set count times or press <Setup> to skip.
2. Using the number keys, enter the Lab Background time in seconds.
3. Press <Save> to save the Lab Background time.
4. Use the number keys to enter the Restricted Wipe Count Time in seconds. Press <Save> to record your entry and advance to the Wipe Test procedure.

Your Hospital Name
Address
City, State Zip
(000) 000-0000

WIPE REPORT: RESULTS

DATE: Dec 07, 1993 TIME: 13:25

AREA # 1 Description: _____

Restricted, RSO trigger level at 100 % of Federal guidelines.

Isotope:	Cs-137	Co-57
Trigger in dpm:	2000	20000
Det. probability	0.99	0.99

Wipe	Description	dpm	dpm
1)	_____	-65	0
2)	_____	5865*▪	71
3)	_____	-88	36
4)	_____	-30	0
5)	_____	18	47
6)	_____	-53	36
7)	_____	6	24
8)	_____	29	24
9)	_____	-65	-35
10)	_____	-53	47
11)	_____	134735*▪	16765 ▪

▪ NOTE: 3 MEASUREMENT(S) EXCEEDED THE LOWER LIMIT OF DETECTION
* NOTE: 2 MEASUREMENT(S) EXCEEDED THE TRIGGER LEVEL

Technologist:_____

Comments:_____

_____

_____

_____

_____

S/N 955050 D4.0/M4.0

Figure 7. A sample Wipe Test report.

Your Hospital Name
Address
City, State Zip
(000) 000-0000

WIPE REPORT: EFFICIENCY AND LLD

DATE: Dec 07, 1993 TIME: 13:20

DETECTOR: WELL GEOMETRIC EFFICIENCY: 85 %

ISOTOPE SETUP:

ISOTOPE	GAIN	LEFT ROI KEV	RIGHT ROI KEV	DETECTOR EFFICIENCY %
Co-57	12	103	158	100
Cs-137	2	561	761	100

WIPE COUNT TIME:	RESTRICTED AREA AND SEALED SOURCE:	6 Seconds
	UNRESTRICTED AREA WIPE COUNT TIME:	5 Seconds
WIPE RECOUNT TIME:	RESTRICTED AREA AND SEALED SOURCE:	10 Seconds
	UNRESTRICTED AREA WIPE RECOUNT TIME:	11 Seconds
LAB BACKGROUND COUNT TIME:		60 Seconds

BACKGROUND RESULTS:

ISOTOPE	BKG. COUNTS	BKG. RATE CPM	BKG. DPM Equiv.	LOWER LIMIT OF DETECTION DPM Restricted	Unrestricted
Co-57	50	50	58	81	92
Cs-137	155	155	182	121	135

Technologist:_____

Comments:_____

_____

_____

_____

S/N 955050 D4.0/M4.0

Figure 8. A sample Wipe report: Efficiency and LLD.

Wipe Test Procedure

1. At the "Mode #3 Wipe Test" prompt, press the flashing <Select> key. The system prompts the user to "prepare for Lab Background". Press <Bkgnd> to continue. The background will be counted for each gain corresponding to the isotopes used for wipe testing. A minimum of sixty seconds is required to count each gain. (A maximum of five gains can be programmed in the Setup loop. Thus, total minimum counting time for a five gain selection would be 300 seconds.)

2. After completing a background count for each programmed gain, the system prompts: <Data> for efficiency and LLD report, or <*> to continue. Press the flashing <Data> key if a printed report is desired at this point or press <*> to continue without printing. (If you choose to print a report, press <*> after the report is printed to continue.)

   NOTE: *It is recommended that you print out the LLD report to get the background values.*

3. The system now prompts: "Area #1, Wipe #1". Position the indicated wipe and press the flashing <Count> key to count or <*> to advance to the next area. If you select to count, the wipe is counted for each gain corresponding to the isotopes listed for this area in setup.

4. After all counts are completed for Wipe #1, if the contamination level is less than both the LLD and Trigger Level, the display will prompt: "Wipe #1 complete". Press <*> to continue to step #6. If the count level exceeds either the LLD or Trigger Level, individual isotope levels are listed showing if that isotope is above the LLD or Trigger Level. You can then individually count each isotope as described in step #5.

5. At this point, provided the count is less than the LLD or Trigger Level, you can press <Count> to recount or <*> to continue with the next listed isotope. If you select to recount, each isotope will be recounted. After each recount, you can press <Spectrum> to print a spectrum report or <*> to continue counting the next isotope. Press <Clear> at any point to stop recounting and advance to step #6.

   NOTE: *If two isotopes have the same gain, each will be counted simultaneously and an individual spectrum for each isotope can be printed if desired.*

6. When the system has finished counting the current wipe, press <*> to advance to the next wipe or, if finished counting wipes, press <Data> to print. To continue counting, you can now press <Count> to count the next wipe or <*> to advance to the next area. If all wipes and areas that you wish to count have been counted, press <Clear>, then <Data> to print a Wipe Test Report, or press <Clear> again to return to the Mode #3 prompt.

   NOTE: *The unit does not store wipe test information. You must print wipe test data at this point to have hard copy. If you exit out to the Mode #3 prompt by mistake, you can still press <Data> to generate a Wipe Test Report as long as you do not re-enter the Wipe Test mode first. Once you go back into Wipe Test mode, all previous wipe test data is cleared from the system.*

MODE #4: Schilling Measurement

(See Figures 9-11)

NOTE: *The Atomlab 930 uses the Mallinckrodt, Squibb/Bracco or Dicopac Schillings Kit procedures. In order to use the automatic calculation functions of the Atomlab system, you must follow exactly the dilutions called for in the kit insructions. You must then enter a correction factor or use the manual mode of the Atomlab system. If you try to use the automatic Schilling mode useing different dilutions and do not enter a correction factor, your results will not be correct.*

This mode allows the technologist to use a Squibb, Mallinckrodt or Medi+Physics Schilling kit. A step-by-step procedure for the kit selected guides the user through the test. Upon conclusion of the test, a specially designed report is printed with the test results and other useful patient information.

Schilling Measurement Setup

At the "Mode #4, Schilling Measurement " prompt, press the flashing <Select> key. The system responds with an "Enter seconds to count" prompt. Press <Setup> to access the Schilling Setup loop. In the Setup loop you can:

- Select the desired Schilling Measurement kit
- Select Well or Probe

Press <Setup> to select the currently displayed kit and advance to the "Select well or probe" prompt. Make your selection and return to the "Enter seconds count".

Selecting a Schilling Measurement Kit

1. At the "Mode #4 Schilling Measurement" prompt, press the flashing <Select> key. The system responds with an "Enter seconds to count" prompt. The current measurement kit is also displayed. Press <Setup> to enter the Setup loop and use the <Bkgnd/Up Arrow> or <*/Down Arrow> key to scroll through the kit choices. Press <Save> to make your selection. Choose from:

    - Squibb/Bracco
    - Simple Mallinckrodt
    - Normal Mallinckrodt
    - Medi+Physics Dicopac®

NOTE: *The Squibb selection works for both Squibb and Bracco.*

2. After a kit has been selected, the system prompts the user to select either the well or probe. Make your selection. The system advances to the "Enter seconds to count" prompt. You are now ready to begin the Schilling Measurement Procedure with the selected kit.

Schilling Measurement Procedure

NOTE: *Procedures for each measurement kit are explained separately below. You can print a spectrum immediately after completing any count by pressing the <Spectrum> key.*

Squibb/Bracco or Normal Mallinckrodt

(See Figure 9)

1. After selecting Squibb/Bracco or Normal Mallinckrodt as the test kit, enter the Schilling count time in seconds and press the flashing <Save> key.

2. The system prompts the user to prepare for a Lab background. Press the flashing <Bkgnd> key. The screen will display the lab count and save the Lab background data.

3. Following the Lab background count, position the Co-57 Standard and press <Count>. The system performs a Standard count.

4. Position the Urine Sample and press the flashing <Count> key. The sample is counted and the Urine Sample data is saved.

5. Use the numbered keys to enter the Total urine volume in ml., then press the flashing <Save> key.

6. You can now use the numbered keys to enter the Sample urine volume in ml. Press the flashing <Save> key to confirm your entry.

7. At this point, the system prompts the user to enter the Correction factor. Use the numbered keys to make your entry, then press the flashing <Save> key.

    NOTE: *If using a reference from a standard schilling kit the Correction factor will be 100. If using the capsule dilute method with a total volume of 100 ml and a sample of 2 ml, then the Correction factor is 50 (100 divided by 2 = 50).*

Your Hospital Name
Address
City, State Zip
(000) 000-0000

SCHILLING TEST REPORT

DATE: Dec 07, 1993 TIME: 13:29

Patient Name:_____ Patient ID: _____

Patient Room No.:_____

Referring Physician:_____ Date Test Ordered:_____

RADIOISOTOPE ADMINISTRATION:

Detector: Probe

Kit type: Squibb

Isotope: Co-57 Date: Dec 07, 1993

Activity: _____ uCi Time: 13:28

Standard Count Rate: 11064 cpm Lab. Background: 684 cpm

Count Time: 5 seconds

PATIENT:

Sample Count Rate: 7116 cpm

Total Urine Volume: 200 ml

Sample Urine Volume: 20 ml

Correction factor: 1

RESULTS: 619.7 % Co-57 Excreted in Urine.

Technologist:_____

Comments:_____

_____

_____

_____

Physician:_____ Date:_____

S/N 955050 D4.0/M4.0

Figure 9. A sample Schilling Measurement (Squibb or Normal Mallinckrodt) report.

Your Hospital Name
Address
City, State Zip
(000) 000-0000

SCHILLING TEST REPORT

DATE: Dec 07, 1993 TIME: 13:31

Patient Name:_____ Patient ID: _____

Patient Room No.:_____

Referring Physician:_____ Date Test Ordered:_____

RADIOISOTOPE ADMINISTRATION:

Detector: Probe

Kit type: Simple Mallinckrodt

Isotope: Co-57 Date: Dec 07, 1993

Activity: _____ uCi Time: 13:30

Standard Count Rate: 6252 cpm Lab. Background: 2760 cpm

Count Time: 5 seconds

PATIENT:

Sample Count Rate: 6576 cpm

Total Urine Volume: 200 ml

Sample Urine Volume: 4 ml

Correction factor: 100

RESULTS: 54.6 % Co-57 Excreted in Urine.

Technologist:_____

Comments:_____

_____

_____

_____

Physician:_____ Date:_____

S/N 955050 D4.0/M4.0

Figure 10. A sample Schilling Measurement (Simple Mallinckrodt) report.

Your Hospital Name
Address
City, State Zip
(000) 000-0000

SCHILLING TEST REPORT

DATE: Dec 07, 1993 TIME: 13:34

Patient Name:_____ Patient ID: _____

Patient Room No.:_____

Referring Physician:_____ Date Test Ordered:_____

Detector: Well

Kit type: medi+physics Dicopac (R) Activity: _____ uCi

Administration Date: _____ Time: _____
Total Urine Volume: 200 ml Sample Urine Volume: 20 ml

$$\text{ALIQUOT CORRECTION FACTOR} = \frac{\text{TOTAL URINE VOLUME}}{\text{URINE ALIQUOT COUNTED}} = U = 10.00$$

1.	Background at Co-57 setting :	r =	14
2.	Background at Co-58 setting :	s =	18
3.	Co-58 STD counts at Co-58 setting :	(z) =	69
4.	Co-58 STD minus Co-58 bkg yields net Co-58 STD :	(z)-s = z =	51
5.	Co-58 STD counts at Co-57 setting :	(y) =	28
6.	Co-58 STD counts in Co-57 ROI minus Co-57 bkg yields net Co-58 at Co-57 setting :	(y)-r = y =	14
7.	Co-57 STD counts at Co-57 setting :	(x) =	32
8.	Co-57 STD minus Co-57 bkg yields net Co-57 STD :	(x)-r = x =	18
9.	"spill-down" factor (Co-58 in Co-57 ROI) :	y/z = f =	0.2745
10.	Urine aliquot counts at Co-57 setting :	(a) =	14
11.	Aliquot Co-57 counts minus Co-57 bkg yields net urine Co-57 counts :	(a)-r = a =	0
12.	Urine aliquot at Co-58 setting :	(b) =	14
13.	Aliquot Co-58 counts minus Co-58 bkg yields net urine Co-58 counts :	(b)-s = b =	-4
14.	The number of Co-58 counts that have "spilled down" into the Co-57 urine setting:	b x f = SD =	0
15.	Net urine Co-57 counts minus "spilled down" counts yields true aliquot Co-57 counts :	a-SD = c =	0
16.	**The % excretion of Co-57 :**	*2 x U x (c / x) =	0.0%
17.	**The % excretion of Co-58 :**	*2 x U x (b / z) =	-1.5%
18.	**Excretion ratio :**	(% Co-57) / (% Co-58) =	0.00

*Each 1.0 ml of standard contains 2% of the radioactivity in the corresponding capsule.

(R) Registered Trademark

Technologist:_____

Comments:_____

_____

Physician:_____ Date:_____

S/N 955050 D4.0/M4.0

Figure 11. A sample Schilling Measurement (Medi+Physics Dicopac) report.

8. The system now displays the percent of Co-57 contained in the urine sample. Press the flashing <Save> key to record the results displayed.

9. To return to the Mode #4 prompt without printing a hard copy report, press <Clear>. To print a hard copy report, press the flashing <Data> key. After printing, the system returns to the Mode #4 prompt.

   NOTE: *The study must be printed at this point if hard copy is desired. You cannot come back and print a test once you have elected to skip the print option. To print a second copy of the report, press the <Data> key immediately after the first report is printed.*

Simple Mallinckrodt

(See Figure 10)

1. After selecting Simple Mallinckrodt as the test kit, enter the Schilling count time in seconds and press <Enter>.

2. The system prompts the user to prepare for a Lab background. Press the flashing <Bkgnd> key. The screen will display the lab count and save the Lab background data.

3. Following the Lab background count, position the Co-57 Standard and press the flashing <Count> key. The system performs a Standard count.

4. Position the Urine Sample and press the flashing <Count> key. The sample is counted and the data saved.

5. You can now use the numbered keys to enter the Total urine volume in ml. Press the flashing <Save> key to confirm your entry.

6. The system now displays the percent of Co-57 contained in the urine sample. Press the flashing <Save> key to record the results displayed.

   NOTE: *The study must be printed at this point if hard copy is desired. You cannot come back and print a test once you have elected to skip the print option. To print a second copy of the report, press the <Data> key immediately after the first report is printed.*

7. To return to the Mode #4 prompt without printing a hard copy report, press <Clear>. To print a hard copy report, press the flashing <Data> key. After printing, the system returns to the Mode #4 prompt.

Medi+Physics Dicopac®

(See Figure 11)

1. After selecting Medi+Physics Dicopac® as the test kit, enter the Schilling count time in seconds and press <Save>.

2. The system next prompts the user to prepare for a Lab background. Press the flashing <Bkgnd> key. The screen will display the lab count and save the Lab background data.

3. Following the Lab background count, position the Co-57 Standard and press <Count>. The system performs a Standard count and saves the Co-57 data.

4. Position the Co-58 Standard and press <Count>. The system performs a Standard count and saves the Co-58 Standard data.

5. Position the Urine Sample and press <Count>. The sample is counted and the data saved.

6. Use the numbered keys to enter the Total urine volume in ml., then press the flashing <Save> key.

7. Use the numbered keys to enter the Sample urine volume in ml., then press the flashing <Save> key.

8. The system now displays the percent of Co-57, the percent of Co-58, and the ratio contained in the urine sample. Press the flashing <Save> key to record the results displayed.

   NOTE: *The study must be printed at this point if hard copy is desired. You can not come back and print a previous test once you have elected to skip the print option. To print a second copy of the report, press the <Data> key immediately after the first report is printed.*

9. To return to the Mode #4 prompt without printing a hard copy report, press <Clear>. To print a hard copy report, press the flashing <Data> key. After printing, the system returns to the Mode #4 prompt.

MODE #5: MCA Manual Mode

(See Figures 12-14)

The MCA Manual mode is used as a rate counter that can be started and stopped, and to print the spectrum obtained. In this mode you can count continuously, count by preset time, or count by preset counts.

NOTE: *The counts are corrected for real time and are not raw counts.*

MCA Manual Mode Setup

At the "Mode #5, MCA - Manual Usage" prompt, press the flashing <Select> key. The system response will depend on the currently selected counting format. Whatever the prompt, press the <Setup> key to access the MCA Mode Setup loop. In this loop you can:

- Select well or probe
- Select counting format (preset time, preset counts or continuous counting)

Select Well or Probe

After pressing <Setup> to enter the Setup loop, the system prompts the user to choose well or probe. Make the appropriate selection. The system next prompts the user to select the desired counting format.

Select Counting Format

Following selection of well or probe, the system displays the current counting format. To keep the current format and advance to the MCA Manual Mode Procedure, press <Save>.

To change the counting format:

1. Use the <Up Arrow> or <Down Arrow> keys to scroll between the three counting formats. Press <Save> to select the desired format. The system is now ready for manual counting. Each of the three counting formats are described below.

MCA Manual Mode Procedure

Continuous Counting

1. To count a known isotope, press the appropriate isotope key at the "Press Count" prompt. To count an undetermined isotope, press the <Other> key. The system begins to count in a continuous manner, starting at the number 1 and increasing. The running count time is displayed in the upper right hand corner of the display.

   NOTE: *The preset ROI for the <Other> key is 117 keV to 2,000 keV with a gain of 1. This can be changed in the system Setup loop.*

2. Press the <*> key to stop the count at any point. To begin counting again, press either <Count> or an appropriate isotope key. The system resets to zero and begins a new continuous count.

3. Once the count is stopped, the <Data> key begins to flash. Press this key to generate an MCA - Manual Mode Report or press <Count> or an appropriate isotope key to begin a new count. The first time you press <Data>, headings will be printed on the report along with the first line of data. If you resume counting, a new line of data will be added to the report each time you follow a count by pressing <Data>. To complete the report and exit back to the "Mode #5 - MCA Usage" prompt, press <Clear>.

   NOTE: *If you change isotopes the report will end and a new report will be printed with the new isotope when the <Data> key is pressed.*

4. If desired, press <Spectrum> to generate a printed spectrum report. Press the <Clear> key to exit back to the Mode #5 prompt once printing has finished.

   NOTE: *To set a custom ROI, go to the general setup mode and change the ULD and LLD for one of the keys. Then return to the MCA manual mode.*

Count By Preset Time

1. At the "Enter preset count time" prompt, press <Save> to keep the displayed count time and proceed to step #2 or enter a new count time in seconds and press the flashing <Save> key.

2. To count a known isotope press the appropriate isotope key, or press <Count> if the currently selected isotope is desired. To count an undetermined isotope, press the <Other> key. The system begins to count, starting with the number 1, until reaching the preset time limit. The running count time is displayed in the upper right hand corner of the main display.

   NOTE: *The preset ROI for the <Other> key is 117 keV to 2,000 keV with a gain of 1.*

3. Press the <*> key to stop the count at any point. To begin counting again, press either <Count> or an appropriate isotope key. The system resets to zero and begins a new count.

4. Once the count is stopped, the <Data> key begins to flash. Press this key to generate a MCA - Manual Mode Report or press <Count> or an appropriate isotope key to begin a new count. The first time you press <Data>, headings will be printed on the report along with the first line of data. If you take additional counts, a new line of data will be added to the report each time you follow a count by pressing <Data>. To complete the report and exit back to the "Mode #5 - MCA Usage" prompt, press <Clear>.

5. If desired, press <Spectrum> to generate a printed spectrum report. Press the <Clear> key to exit back to the Mode #5 prompt.

   NOTE: *If you change isotopes the report will end and a new report will be printed with the new isotope when the <Data> key is pressed.*

Count By Preset Counts

1. At the "Enter preset count" prompt, press <Save> to keep the displayed count time and proceed to step #2 or enter a new count time in seconds and press the flashing <Save> key.

2. To count a known isotope press the appropriate isotope key, or press <Count> if the currently selected isotope is desired. To count an undetermined isotope, press the <Other> key. The system begins to count, starting with the number 1, until reaching the preset time limit. The running count time is displayed in the upper right hand corner of the main display.

   NOTE: *The preset ROI for the <Other> key is 117 keV to 2,000 keV with a gain of 1.*

3. Press the <*> key to stop the count at any point. To begin counting again, press either <Count> or an appropriate isotope key. The system resets to zero and begins a new count.

4. Once the count is stopped, the <Data> key begins to flash. Press this key to generate a MCA - Manual Mode Report or press <Count> or an appropriate isotope key to begin a new count. The first time you press <Data>, headings will be printed on the report along with the first line of data. If you take additional counts, a new line of data will be added to the report each time you follow a count by pressing <Data>. To complete the report and exit back to the "Mode #5 - MCA Usage" prompt, press <Clear>.

5. If desired, press <Spectrum> to generate a printed spectrum report. Press the <Clear> key to exit back to the Mode #5 prompt.

   NOTE: *If you change isotopes the report will end and a new report will be printed with the new isotope when the <Data> key is pressed.*

Your Hospital Name
Address
City, State Zip
(000) 000-0000

MANUAL MCA MODE- PRESET TIME

PROCEDURE: _____

TEST DATE: Dec 07, 1993 TIME: 13:36

ISOTOPE / ACTIVITY: Co-57 / _____ TECH:_____

PRESET TIME: 60 Seconds

DETECTOR: PROBE

WINDOW / ROI: 104 keV TO 156 keV GAIN: 12

Reference	Hour	Count Time (Seconds)	ROI Counts	ROI cpm	Total Counts	Total cpm
_____	13:35	60	4906	4906	42563	42563
_____	13:35	60	4906	4906	42563	42563
_____	13:37	60	4854	4854	42460	42460

CALCULATIONS:

COMMENTS: _____

_____

_____

S/N 955050 D4.0/M4.0

Figure 12. A sample MCA Manual Mode report – Preset Time.

Your Hospital Name
Address
City, State Zip
(000) 000-0000

MANUAL MCA MODE- CONTINUOUS COUNTING

PROCEDURE: _____

TEST DATE: Dec 07, 1993 TIME: 15:28

ISOTOPE / ACTIVITY: Cs-137 / _____ TECH: _____

DETECTOR: WELL

WINDOW / ROI: 562 keV TO 761 keV GAIN: 2

Reference	Hour	Count Time (Seconds)	ROI Counts	ROI cpm	Total Counts	Total cpm
_____	15:27	33	16137	29340	49576	90138
_____	15:30	18	8791	29303	27136	90453
_____	15:31	66	32472	29520	98808	89825

CALCULATIONS:

COMMENTS: _____

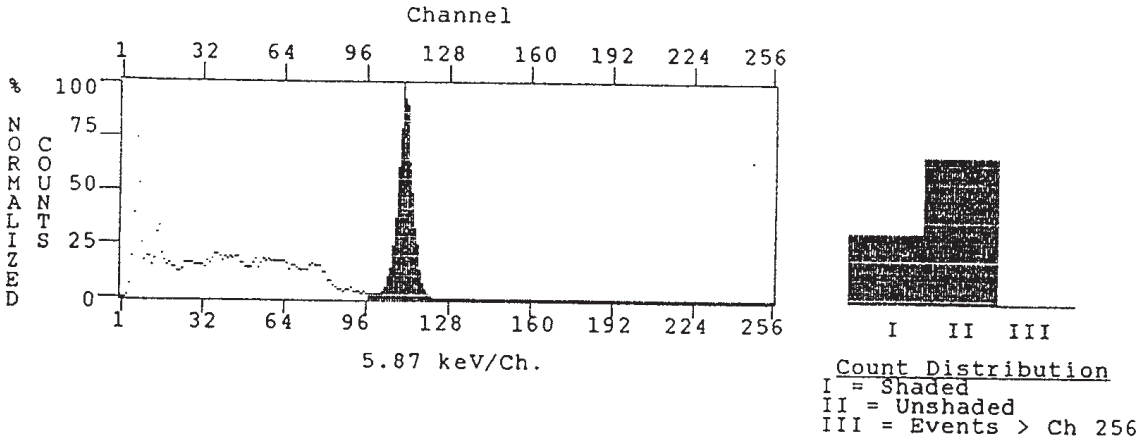
S/N 955050 D4.0/M4.0

Figure 13. A sample MCA Manual Mode report – Continuous Counting.

Your Hospital Name
Address
City, State Zip
(000) 000-0000

Spectrum Report

DATE: Dec 07, 1993 TIME: 15:32



The above spectrum was collected under the following conditions:

Mode: MCA - Manual Usage mode

ID: N/A

Isotope: Cs-137

Detector: Well

Gain: 2

Count type: Continuous counting

Spectrum Analysis:

Peak: Energy = 649 keV; Count = 4390; Rate = 3991 cpm

ROI 1: Energy = 562 keV to 761 keV; Count = 32472; Rate = 29520 cpm

Total: Count = 98808; Rate = 89825 cpm

Count Time: 66 seconds.

Events above channel 256: 81 counts

S/N 955050 D4.0/M4.0

Figure 14. A sample Spectrum report.

APPENDIX I

ATOMLAB 930 ERROR MESSAGES

ERROR #	DESCRIPTION
01	Battery voltage is low
02	Display unit checksum failed
03	Display RAM failure
04	MCA critical value checksum failure
05	Setmca () isotope record is invalid
09	ROI is narrow
10	Count rate is <10,000 cpm
11	Count rate is >600,000 cpm
12	No peak in ROI
13	Communication failure
15	MCA clock failure
20	High energy peak
21	Low energy peak
22	Cs-137 Upper ROI is out of range
23	Cs-137 Lower ROI is out of range
24	High count rate. No correction factor
25	Schilling background > standard
26	EEPROM contains bad information
102	General failure
no #	Error: Byte #___ did NOT verify!
no #	Standard is too old
no #	Error: No patients

APPENDIX II

SYSTEM SPECIFICATIONS

MEDICAL SPECTROMETER HARDWARE:
Multi-Channel Analyzer
Channels: 256
Inputs: Probe and well
Spectral Resolution: FWHM 10%
Count Rate: (Maximum) 100,000 cps
Count Rate Stability: 99%
Gross Count Rate Linearity: Within 5% up to 100,000 cps
Pulse Height Linearity: Within 2% (independent of detector)
Connectors: Signal (BNC); high voltage (MHV)
Power Supply: Regulated from 775-1225 VDC at 2 mAmps
Detector High Voltage Adjustment: Automatic H.V. adjustment for both probe & well. Uses 10 mCi Cs-137 as the calibration source.
Amplifier Gain: Automatic/User-defined. Contains built in pre-amplifier for direct connection to tube base.
Automatic gain switching with isotope selection: 1, 2, 4, 8, 12, 48
Radionuclide: Seven pre-selected radionuclides: I-123, I-125, I-131, Co-57, Cr-51, Tc-99m and Cs-137. Also one user-identified isotope selection.
Energy Level Discriminators: Preset/User-defined LLD-ULD.
Preset Time: 0-9999 seconds
Clock Speed: 10 MHz (MCA)
Display: LCD 2 Line
Viewing Area: 154 mm w x 15.3 mm h
Characters: 3.2 mm w x 4.85 mm h
Printer Output Port: RS-232 serial port
Processor:
-MCA Processor: DSP, 10 M.I.P.S.
-Micro Controller: 12 MHz
-(keyboard, display, printer)
Dimensions: 12" w x 14" l x 3.5" h (31 x 36 x 9 cm)
Weight: 8 lb (3.6 kg)
Power: 115/230 VAC, 50/60 Hz
Printer: Serial Printer with 32K memory

MEDICAL SPECTOMETER PROGRAMS
Programs: Thyroid Uptake, Wipe Test, Bioassay, Schilling Test, Administration/QA, Manual MCA

Radionuclides:
Factory Programmed: I-123, I-125, I-131, Co-57, Cr-51, Tc-99m, Cs-137 and one user defined

Wipe Test Software Choices: Am-241, Au-198, BA-133, Co-57, Co-58, Co-60, Cr-51, Cs-137, Fe-59, Ga-67, Hg-197, Hg-203, I-123, I-125, I-131, In-111, Ir-192, K-42, Na-24, Pd-103, Se-75, Sr-85, Tc-99m, TI-201, Yb-169 and 5 user defined isotopes

OTHER HARDWARE:
Probe: 2" x 2" Nal (T1) integral line scintillation detector with tube base

Uptake Stand:
Dimensions: 39" l x 30" w x 62" h (99.1 x 76.2 x 157.5 cm)
Arm: Counterbalanced, two section arm, moves 22.5" vertically and extends 29" horizontally from stand's vertical column.
Casters: 3" maxi-lok
Weight: 296 lb (134.3 kg)

187-246 Well Counter:
Detector: 2" x 2" Nal (T1) integral line detector with a .75" diameter x 1.44" deep well (1.9 x 3.7 cm)
Lead Shielding: 1" thick (2.5 cm)
Cover: .125" thick (.32 cm)
Connectors: Signal (BNC), high voltage (MHV)
Weight: 54 lb (24.5 kg)

Optional:
187-256 Well Counter:
Lead Shielding: 2" thick (5 cm)
Cover: .125" thick (.32 cm)

Certification: ETL Listed to UL 2601 Std. and CAN CSA C22.2 No. 601.1-M90 and CE approved.

APPENDIX III

ELECTROMAGNETIC COMPATIBILITY

NOTE: *This MEDICAL ELECTRICAL EQUIPMENT needs special precautions regarding EMC and needs to be installed and put into service according to the EMC information provided in the ACCOMPANYING DOCUMENTS. See chart on next page*

NOTE: *Portable and mobile RF communications equipment can affect MEDICAL ELECTRICAL EQUIPMENT.*

NOTE: *Contact Biodex Medical Systems for additional EMC information.*

ELECTROMAGNETIC COMPATABLILTY FOR ATLOMAB 930

Standard	Test Method	Range			Limits	Result
IEC 61000-3-2	Harmonics	100 Hz to 2KHz			Class A	THD = 64.86%
IEC 61000-3-3	Flicker	observation time (TP) 10 min			-	-
		max voltage change (dmax)			4%	.55%
		max Rel steady state voltage change (dc)			3%	.04%
		duration of d(t)>3%(t)			.2 sec	0.00 sec
		short term flicker Sev (PST)			1.00	.07
		long term flicker Sev (PLT)			.65	.07
IEC 61000-4-2	Electrostatic Discharge	Contact: 4 & 6Kv pos/neg 1pps for 10 sec Air: 2, 4, & 8Kv pos/neg 1pps for 10 sec			no degradation of performance	complied
IEC 61000-4-3	Radiated Immunity	80 MHz to 2500 MHz/3v/m/Horiz & Vertical @ 1M			no degradation of performance	complied
IEC 61000-4-4	Electrical Fast Transient/Burst, Power Leads	PWR Input leads .5, 1, & 2 Kv / pos & neg / 5KHz Rep Rate			no degradation of performance	complied
IEC 61000-4-6	Conducted Immunity, Power Leads	150 KHz to 80 MHz /3Vrms			no degradation of performance	complied
IEC 61000-4-8	Magnetic Immunity	3A/M RMS @ 50/60 Hz			no degradation of performance	complied
IEC 61000-4-11	Voltage Dips and Interrupts	**Int Duration**	**Pause between**	**% reduction**	no degradation of performance	complied
		Int 20msec	pause 10 sec	>95%	no degradation of performance	complied
		Int 100msec	pause 10 sec	60%	no degradation of performance	complied
		Int 500msec	pause 10 sec	30%	no degradation of performance	complied
		Int 5000msec	pause 10 sec	>95%	no degradation of performance	complied
CISPR 11	Conducted Emissions	150 KHZ-30 MHz, Class A, Group 1			79/73 dbuV QP 66/60 dbuV AV	complied
CISPR 11	Radiated Emissions	30 MHz – 1GHz, Class A, Group 1			30/37 dbuVm @ 30 m	complied
IEC 61000-4-5	Surge Immunity, Power Leads	1 Kv, differential, 2 Kv Commons, 1ppm 5 Pos, 5 Neg for total of 10			no degradation of performance	complied

3/28/05

APPENDIX IV

SCHEMATICS

The Schematics listed below are on the following pages.

- Schematic Controller
- Assembly, PC B Keyboard Thyroid Uptake
- Schematic, Keyboard Atomlab 100-200
- Schematic, 80 Character Display
- Assembly, PC B, MCA
- Schematic, MCA/HZ, page 1 of 2
- Schematic, MCA/HZ, pae 2 of 2
- Assembly, PCB Display
- Assembly, PC Board Controller, 900

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